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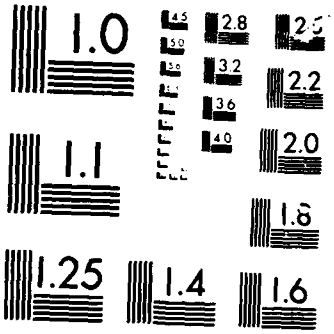

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US Department
of Transportation
Federal Aviation Administration

A Benefit-Cost Analysis of the Airport Improvement Program (AIP), Fiscal Years 1982 Through 1985

Office of Aviation
Policy and Plans
Washington, D.C. 20591

FAA-APO-86-3

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EXECUTIVE SUMMARY

INTRODUCTION

This report assesses the major benefits and costs of airport capital and planning investments in the U.S. public airport system, focusing primarily on investments made under the current federal airport program--the Airport Improvement Program (AIP). While the study centers on the AIP, its findings and conclusions generally apply to airport airside investments from other funding sources as well, e.g., non-AIP state and local funding. An estimate is made of the major airside life-cycle benefits that have accrued and that are expected to accrue from capital and planning investments made under the AIP from FY 1982 through FY 1985 inclusively and their attendant life-cycle operations and maintenance costs. Because not all types of benefits are quantified, the analysis should be considered conservative in that it probably understates total investment impact.

Benefits addressed in this report are improved airport safety, preservation of airport capacity, environmental protection and economic development. While benefits are estimated by type, airport capital investments generally generate more than one type of benefit. In the areas of safety, capacity and environmental protection, what is measured are the benefits that would be foregone if AIP investments not been made over the FY 1982 through FY 1985 study period. In the case of economic development benefits, what is measured is the increase in the Gross National Product induced by the investments. Benefits accruing to local and regional economies from recurring support and operating expenditures in airports are recognized and discussed but not quantified.

SUMMARY OF FINDINGS

Table E-1 summarizes the findings of the study. As illustrated, the life-cycle benefits total $25.28 billion (1985 dollars at 1985 discounted present value). Comparing this with the associated life-cycle costs of $6.32 billion yields a benefit/cost ratio of 4.00 to 1. Of these totals, the federal shares of life-cycle benefits and costs are estimated to be $11.53 billion and $2.89 billion respectively.

TABLE E-1

Summary of Life-Cycle Benefit/Cost Findings
(Billions of 1985 Dollars at 1985 Discounted Present Value)

Life-Cycle Benefits		
Direct Benefits -- Safety, Capacity, Environmental Protection	$ 9.48	
Indirect Benefits -- Economic Development	15.79	$25.28
Life-Cycle Costs		$ 6.32
Benefit/Cost Ratio		4.00

SAFETY, CAPACITY, AND ENVIRONMENTAL PROTECTION BENEFITS

Airport airside safety projects, in conjunction with other FAA programs impacting airport safety, have contributed to an impressive aviation safety record which serves as a benchmark for the rest of the world. To estimate safety benefits of AIP airside projects, historic (pre-1982) accident data are reviewed to identify accidents that occurred in or about the environs of an airport that may have been reduced by airside investments characteristic of those funded under the AIP. The rates and costs of the "AIP-mitigated" accidents so identified declined from CY 1970 through CY 1981. Baseline annual costs of AIP-mitigated accidents incorporating this declining rate are projected into the post-FY 1981 time period assuming that AIP funding has had and will have the same relative contribution to safety as that achieved from CY 1970 through CY 1981. Scenarios are then postulated on post-1981 AIP-mitigated accidents assuming the absence of AIP funding from FY 1982 through FY 1985. The differences between AIP-mitigated accident costs under each scenario and those under the baseline are used to quantify the safety benefits.

A major concern of airport users and aircraft operators is flight disruptions, such as delays, diversions, and cancellations. A principal cause of these disruptions is lack of airport capacity, meaning that certain airports do not have facilities in sufficient quantity to accommodate efficiently all those who want to use the airports at peak periods of demand. Flight disruptions in turn impose costs on users in the form of "lost" or "wasted" time and on aircraft operators in the form of increased aircraft operating costs and foregone revenues. To value a portion of the capacity benefits of the AIP, estimates are made of the reduced costs experienced by airport users and aircraft operators as a result of AIP investments in reliever airports and seal coating and resurfacing airport runways. Forecast costs with these investments are compared with forecast costs without the investments. The differences constitute the capacity benefits. A major limitation of this analysis is the omission of benefit estimates of projects which provide increments of new capacity. Such estimates require simulation modeling, a technique beyond the current study's resource and time limits.

Measurement of the benefits of noise reduction is a highly subjective exercise due to the very nature of noise disbenefits--annoyance, disturbance of sleep, interference with conversation, and detraction from the enjoyable use of property. Therefore, the quantification approach taken in this benefit area is an indirect one. Benefits are measured by reference to night-time operating hour restrictions or curfews that might result without AIP investments for noise abatement. The benefits stem from aircraft operations that would otherwise be prohibited.

The combined interdependent safety, capacity and environmental protection life-cycle benefits from AIP investments made from FY 1982 through FY 1985 inclusively total at least $9.48 billion (1985 dollars at 1985 discounted present value). Of this total, the allocated federal share is $4.32 billion.

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15. Supplementary Notes

16. Abstract

This report assesses the major benefits and costs of airside capital and planning investments in the U.S. public airport system. The assessment centers on the Airport Improvement Program (AIP), the current federal airport grant program, but the findings and conclusions are also applicable to airport projects funded by other sources -- e.g., non-AIP state and local funding. An estimate is made of the major airside life-cycle benefits that have accrued and that are expected to accrue from capital and planning investments made under the AIP from FY 1982 through FY 1985 inclusively and their attendant life-cycle operations and maintenance costs. Because not all types of benefits are quantified, the study should be considered conservative in that it probably understates total investment impact.

Benefits consist of improved airport safety, preservation of airport capacity, environmental protection and economic development. Costs consists of capital and planning investments and the attendant life-cycle operations and maintenance costs. The life-cycle benefits quantified total $25.28 billion (1985 dollars at 1985 discounted present value). Comparing this with the corresponding life-cycle costs of $6.32 billion yields a benefit/cost ratio of 4.00 to 1.

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ECONOMIC DEVELOPMENT BENEFITS

Beyond the "direct" benefits of the AIP in the areas of safety, capacity, and environmental protection, there are benefits realized in the form of economic development. Civil aviation is a major component of the national economy and has a major impact on our life styles. Much of this impact would not be possible without modern airports funded in part by the AIP. Many airports are major contributors to their local economies, and in some cases major employers. In addition, airport investments foster general economic growth and development by lowering costs of production and control and by making possible new industries.

One impact on the economy arising from federal airport grants is the increase in the Gross National Product (GNP) associated with federal spending per se. An increase in GNP equal to AIP federal expenditures occurs as funds are initially expended. Additionally, GNP will be generated as these monies are again spent and re-spent. The cumulative impact can be estimated by applying an appropriate multiplier to the initial federal AIP expenditures ($2.88 in 1985 dollars at 1985 discounted present value). Applying a multiplier of 2.5 yields an estimate of the economic impact of federal AIP airside investments of $7.20 billion (1985 dollars at 1985 discounted present value).

Federal AIP expenditures also stimulate state and local investments in airports in two ways. First, AIP grant provisions require that federal funds be complemented by state and local funds. Second, state and local sponsors are required to fund related operations and maintenance costs. The impact of state and local spending is akin to federal spending. The impact on GNP of state and local AIP investment shares may be quantified, as above with federal expenditures, by applying the multiplier (2.5) to the present value of the state/local AIP expenditures ($3.43 billion in 1985 dollars at 1985 discounted present value). This yields an impact of $8.59 billion. Additionally, because only certain projects are eligible for AIP funding, a need arises for investment in complementary projects which must be undertaken with non-AIP state and local funds. For example, AIP-eligible projects are primarily airside in nature. As these are undertaken, it is necessary to undertake associated landside projects. The economic impact of these non-AIP investments and state and local recurring operating and support expenditures are not quantified in this report.

COSTS

The costs of interest in this report are summarized in Table E-2 and include federal investments authorized under the AIP and the STAA (Surface Transportation Assistance Act of 1982) from FY 1982 through FY 1985 inclusively, the corresponding state and local shares, and the attendant operations and maintenance costs associated with these investments over their estimated economic lives. As outlined in Table E-2, these costs total $7.61 billion (1985 dollars at 1985 discounted present value). Of this total, $6.32 billion is associated with the airside benefits quantified in this report, with $2.88 billion allocable to the federal share and $3.44 billion allocable to state/local levels.

TABLE E-2

Federal and State/Local Life-Cycle Costs Associated With AIP Investments From FY 1982 - FY 1985 a/

(Billions of Current Year Dollars, Except as Noted)

	Federal			State/Local			
Fiscal Year	Basic AIP Authorization b/	STAA Funds c/	Sub-Total	Capital d/	Support (Opns & Maint) e/	Sub-Total	Total
1982	0.4500	0.0000	0.4500	0.1264	0.0000	0.1264	0.5764
1983	0.6000	0.2000	0.8000	0.1686	0.0517	0.2203	1.0203
1984	0.7935	0.2000	0.9935	0.2094	0.1206	0.3300	1.3235
1985	0.9120	0.0750	0.9870	0.2385	0.2106	0.4491	1.4361
1986					0.3138	0.3138	0.3138
1987					0.3185	0.3185	0.3185
1988					0.3233	0.3233	0.3233
1989					0.3281	0.3281	0.3281
1990					0.3331	0.3331	0.3331
1991					0.3381	0.3381	0.3381
1992					0.3431	0.3431	0.3431
1993					0.3483	0.3483	0.3483
1994					0.3535	0.3535	0.3535
1995					0.3588	0.3588	0.3588
1996					0.3642	0.3642	0.3642
1997					0.3696	0.3696	0.3696
1998					0.3752	0.3752	0.3752
1999					0.3808	0.3808	0.3808
2000					0.3865	0.3865	0.3865
2001					0.3923	0.3923	0.3923
2002					0.3982	0.3982	0.3982
2003					0.3922	0.3922	0.3922
2004					0.3864	0.3864	0.3864
2005					0.3806	0.3806	0.3806
Total Current Yr. $	2.7555	0.4750	3.2305	0.7428	7.5675	8.3103	11.5408
Total Constant 1985 $	2.8433	0.4890	3.3323	0.7673	6.3024	7.0697	10.4020
1985 Present Value (1985 $)	3.2197	0.5536	3.7733	0.8716	2.9673	3.8390	7.6123

a/ Values may not sum to printed totals due to independent rounding.
b/ Based on obligating authority.
c/ As authorized by the Surface Transportation Assistance Act (STAA) of 1982. Amounts based on obligating authority.
d/ Based on state/local sponsor participation percentages of total (Federal+State/Local) investment other than STAA.
e/ Assumes a one-year lag between authorization year and operational readiness, and a 20-year economic life.

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CHAPTER I - INTRODUCTION

A. PURPOSE OF REPORT

The United States, having the largest and most complex and technologically advanced system of airports in the world, has a considerable investment in its airport system. From FY 1947 through FY 1981, it is estimated that cumulative capital and planning investment in the Nation's airports from federal grant programs and complimenting state and local shares totaled $8.2 billion (or $17.6 billion in constant 1985 dollars), of which the federal share accounted for $5.9 billion (or $11.7 billion in constant 1985 dollars) or about two thirds.

To accommodate safely and efficiently the increasing demand for airport services, the FAA projects a need for substantial investment in upgrading, maintaining and expanding the airport system. Of investments projected to be eligible for Federal aid under the current federal airport grant program - the Airport Improvement Program (AIP) (Reference 2) - the total cost of national airport system development needs over the ten-year period FY 1984 through FY 1993, including federal and local shares, has been estimated to total $18.3 billion (in mixed 1983/1984 dollars), or $1.8 billion annually (Reference 1). Of this amount, the Federal share is projected to be approximately $8.4 billion.

In light of the magnitude of prior expenditures and in support of future investments in the U.S. public airport system, this report assesses the major airside life-cycle benefits and associated costs of airport capital and planning investments, focusing primarily on investments made under the AIP from FY 1982 through FY 1985 inclusively. While the study centers on the AIP, its findings and conclusions generally apply to airport airside investments from other funding sources as well, e.g., non-AIP state and local funding. Because not all types of benefits are quantified, the analysis should be considered conservative in that it probably understates total investment impact.

B. ORGANIZATION OF REPORT

Following this introductory section, the remainder of this chapter provides a brief overview of the U.S. airport system and history of federal policy and involvement in airport development. Chapter II outlines historic and forecast federal capital and planning investment under airport grant programs. Chapter III describes the benefit categories and summarizes the findings, followed by Chapters IV through VI which address benefits in the areas of safety (Chapter IV), capacity and environmental protection (Chapter V), and economic development (Chapter VI). While the benefits are estimated separately by type, it should be noted that airport capital investments generally generate more than one type of benefit. The benefit and cost findings are consolidated in Chapter VII to provide an overall summary assessment of the benefit/cost ratio that can be advocated for the AIP over the FY 1982 through FY 1985 study period. As mentioned above, the findings and conclusions can be advocated also for other funding sources, e.g., non-AIP state and local funds. Finally, several appendices are provided in the interest of disclosing sufficient detail supporting the individual analyses while at the same time keeping the text as readable and comprehensible as possible to a general audience.

The reader should note that dollar values cited in this report are denominated in several ways depending on analytic purpose:

Current year dollars: "As spent" dollars, as conventionally expressed in everyday use, unadjusted for inflation or time value.

Constant dollars: Dollars stated in terms of constant purchasing power. Individual benefit chapters in this report for the most part use 1982 as the base year for stating constant dollar valuations. The end of each benefit chapter reexpresses the findings in 1985 constant dollars.

Discounted present value dollars: Dollars stated as viewed from a common point in time. This valuation accounts for the fact that otherwise equal but nondiscounted benefits and costs which occur at different points in time will not be equal when viewed from a common point in time. Generally, a benefit will be worth more the sooner it is received, and a cost will be less the longer it is deferred. This economic phenomena is the result of two factors: the productivity of capital and the time preference of economic decisionmakers. The need to discount arises because resources currently available can be invested and a larger amount obtained in a future period. Any future amount must be diminished to reflect the present amount required to be invested to yield the future amount. The requirement to discount does not depend upon the existence of inflation. Rather it arises from the productivity of capital and the scarcity of investable resources. Individual benefit and cost chapters in this report, in addition to constant dollars, also present dollar valuations in present value dollars discounted at 10 percent as prescribed by the Office of Management and Budget (OMB) (Reference 14). This permits equivalent comparison of benefits and costs which occur at different points in time.

The reader should also note that the life-cycle assumed in this report is 20 years and that there is assumed to be an average one-year lag between appropriation year and operational readiness of the typical AIP investment.

C. OVERVIEW OF THE U.S. AIRPORT SYSTEM

The system of airports in the United States is the largest and most complex and technologically advanced system in the world. In terms of number of facilities, the U.S. airport system constitutes almost half of the world's total (Reference 3). As of January 1, 1984, as shown in Table I-1 and Figure I-1, there were 16,029 aircraft landing facilities on record with the FAA - 5,987 or 37 percent of which were open to public use. These airports range in size from small unpaved strips used by a handful of private flyers to gigantic commercial air transportation hubs handling more than 500,000 aircraft operations per year. While the U.S. has nearly half of the world's airports, it accounts for two-thirds of the

TABLE I-1

Selected Measures of U.S. Airport System Activity (1983 as indicated)

(Certain data may not add to printed totals due to independent rounding)

Aircraft facilities by type a/:	
Airports	12,653
Heliports	2,918
Stolports	66
Seaplane bases	392
	16,029
Aircraft facilities by ownership a/:	
Publicly-owned	5,987
Private	10,042
	16,029
Aircraft facilities by pavement & lighting a/:	
Paved:	
Lighted	3,939
Unlighted	2,502
Subtotal	6,441
Unpaved	
Lighted	939
Unlighted	8,649
Subtotal	9,588
	16,029
Itinerant passenger enplanements at U.S. stations and by American flag airlines at U.S. territorial stations (millions):	
Scheduled service b/:	
Air carrier:	
Domestic	294.8
International	9.0
Subtotal	303.7
Commuter	19.2
Subtotal	322.9
Unscheduled operations c/	135.6
	458.5
Airline cargo enplaned at U.S. stations and by American flag airlines at U.S. territorial stations (millions of tons) b/:	
Mail	1.2
Freight	2.6
	3.8
Civil aircraft fleet:	
Air carrier d/	2,973
Commuter and air taxi e/	9,556
General aviation f/	204,967
	217,496

Total aircraft operations at FAA facilities (millions) g/:	
Air carrier	9.7
Commuter and air taxi	5.9
General aviation	35.3
Military	2.5
	53.4

a/ Source: Reference 4, based on airports on record with FAA as of 12/31/83. Excludes landing rights airports and Puerto Rico, Virgin Islands, N. Mariana Islands, and South Pacific.

b/ Source: Reference 4, 12 months ended 12/31/83.

c/ Assumes an average itinerant aircraft occupancy factor of 3.2 persons and 200 average annual itinerant aircraft operations for each of the estimated 211,814 aircraft in the subject fleet subpopulation.

d/ Source: Reference 4. Includes certified route air carriers, supplemental air carriers, commercial operators and all cargo operations as of 12/83.

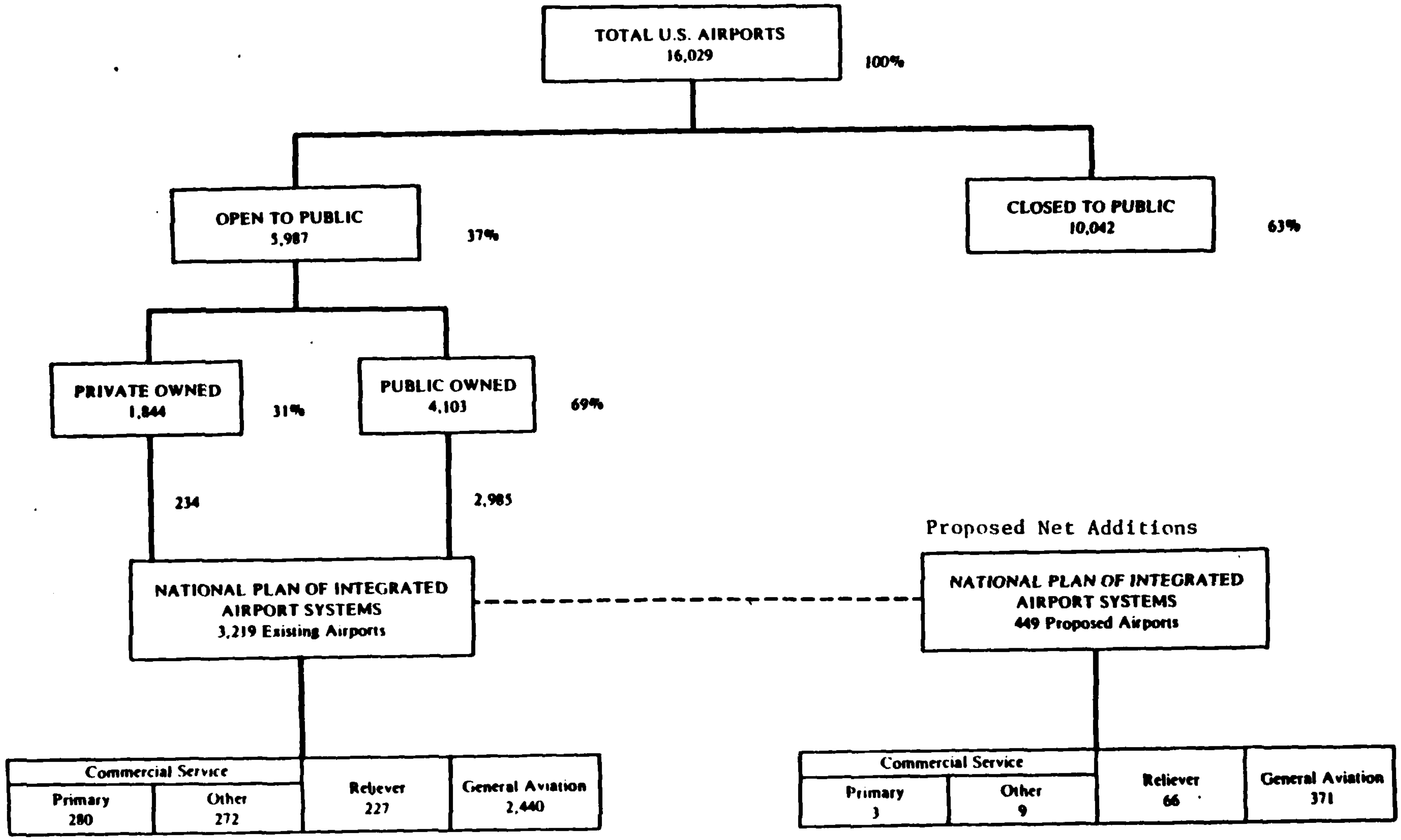
e/ Source: Reference 4, based in part on survey. Includes all aircraft types.

f/ Source: Reference 4, based in part on survey. Includes all general aviation, including air travel clubs, other than commuter and air taxi.

g/ Source: Reference 7.

FIGURE I-1

Division of Airports by Public Use Availability, Ownership and Inclusion in NPIAS
January 1, 1984



Source: Reproduced from Reference 1.

world's 400 busiest airports in terms of passenger enplanements (Reference 3). Collectively, as shown in Table I-1, U.S. and U.S. territorial airports handled over 458 million itinerant passenger enplanements and U.S. airlines handled approximately 3.8 million tons of freight and mail in CY 1983. Table I-1 and Figure I-1 present additional selected data on characteristics of the U.S. airport system.

Of all the airport facilities comprising the U.S. airport system, only a subset serve public transportation and can be deemed of national importance and eligible for Federal aid. Considering only airports which are open for public use and which also have at least one paved, lighted runway, the total of 16,029 landing facilities shrinks to about 3,424 (Reference 4). Under Section 504(a) of the Airport and Airway Improvement Act of 1982, the FAA is charged with preparing and publishing bi-annually a national plan for the development of U.S. public-use airports. The current version of this plan, the National Plan of Integrated Airport Systems (NPIAS) (Reference 1), was released in August 1985. As shown in Figure I-1 and Table I-2, the current NPIAS contains 3,219 existing airports, a number which is projected to grown to 3,668 airports by 1993.

D. HISTORY OF FEDERAL POLICY AND INVOLVEMENT IN AIRPORT DEVELOPMENT

This section provides a brief history of federal policy and involvement in airport development.

1. Air Commerce Act of 1926

The Air Commerce Act of 1926 marked the beginning of federal regulation of air traffic and aviation safety. This legislation recognized that both commercial and military benefits might accrue to the nation if aviation safety could be improved and the manufacture and use of aircraft were fostered and encouraged. While Congress empowered the Department of Commerce to chart the airways, maintain navigation facilities, and act in other ways to promote air commerce, the Air Commerce Act included no provision for federal involvement in airport development and contained a specific prohibition against federal involvement in the construction of airports. In the debate leading to the passage of the Air Commerce Act, Congress considered but rejected the idea that airports were a matter of Federal interest. It was thought that, while airways development was a matter of Federal interest, airport development should be left to local initiative.

2. Civil Aviation Act of 1938

When the Civil Aviation Act was passed in 1938, Congress began to reconsider policy. There was no authorization for airport aid, but neither was it prohibited. Instead, the Act established a new independent agency, the Civil Aeronautics Administration, and directed it to survey and to make a recommendation to Congress about the advisability of federal participation in airport construction and maintenance. In March 1939 the CAA submitted its final report recommending that an adequate system of public airports be recognized, in principle, as a matter of national

TABLE I-2

National Plan of Integrated Airport Systems - Existing and Projected Locations By Service Level a/

Service Level[b/]	Existing Locations (1/1/84)	New Locations	Total Projected Locations (1993)[c/]
Commercial Service			
Primary	280	3	290
Other	272	9	346
	552	12	636
General Aviation			
Reliever Airports			
Basic Utility[d/]	45		
General Utility[e/]	88		
Larger than Utility[f/]	93		
Heliport	1		
	227	66	297
Other General Aviation			
Basic Utility[d/]	1,393		
General Utility[e/]	604		
Larger Than Utility[f/]	396		
Heliport	3		
Seaplane Base	44		
	2,440	371	2,724
Total	3,219	449	3,657

a/ Source: Reference 1.

b/ Primary - Public-use commercial service airports enplaning at least 0.01 percent of all passengers enplaned annually at all U.S. airports. In FY 1983 and FY 1984, 0.01 percent was equivalent to 29,284 and 30,915 enplaned passengers respectively (References 5 and 6).
Other Commercial Service - Other public-use commercial service airports receiving scheduled passenger service and enplaning at least 2,500 passengers annually.
General Aviation - Those airports with less than 2,500 annual enplaned passengers and those used exclusively by private and business aircraft not providing common carrier passenger service.
Reliever - A special subset of general aviation airports which have the functions of relieving congestion at primary commercial service airports and providing more access for general aviation to the overall community. To be classified as a reliever, an airport must handle, at present or within the last two years, 25,000 itinerant or 35,000 local operations annually.

c/ "Existing locations plus "new locations" does not equal "total projected locations" because the service level of many airports is projected to change during the planning period.

d/ Accommodates most single and many smaller twin-engine aircraft.

e/ Accommodates virtually all general aviation aircraft with maximum takeoff gross weights of 12,500 pounds or less.

f/ Accommodates transport and business jets.

concern and a proper object of federal expenditure. In 1940, with World War II in Europe, Congress appropriated $40 million for the construction, improvement, and repair of up to 250 public airports after a determination was made that they were necessary for national defense. This was the first congressional appropriation for airport development to a civil aviation agency. Allocations were promptly made for the development and improvement of 193 sites. The Development of Landing Areas for National Defense Program (DLAND), as the program was known, continued during the war years and eventually $383 million was spent at 535 airports. In 1944, another program, the Development of Civil Landing Areas (DCLA), was inaugurated, and $9.5 million was spent for 29 airports. Also, in 1944 a national airport plan was submitted to Congress by the CAA's Office of Airports, but efforts to establish an airport grant program were not successful.

3. Federal Airport Act of 1946

After World War II, the Federal Government embarked on a grants-in-aid program to further promote the development of a system of airports to meet the nation's needs. The Federal-Aid Airport Program (FAAP) was brought into existence with the passage of the Federal Airport Act of 1946, the first legislation to deal specifically with civil airport development. The FAAP, financed from the General Fund, provided capital grants in the form of matching funds to encourage state and municipal initiative in building and improving publicly-owned airports. From Fiscal Years 1947 through 1969 (with the exception FY 1954 when appropriations were not made), nearly $1.2 billion (current year dollars) in capital grants was provided to 2,316 airports by the FAAP, ranging from $10 to $75 million annually (see Table II-1 in Chapter II for further detail).

4. Airport and Airway Development Act of 1970

During the FAAP years, Congress became increasingly concerned with what amounted to direct subsidy of the aviation industry through General Fund appropriations. It had also become concerned with inadequate airway and airport capacity experienced with the introduction of commercial jet aircraft. Its response to these concerns was the passage of the Airport and Airway Development Act of 1970. The 1970 Act provided for airport development under the Airport Development Aid Program (ADAP) and for airport planning under the Planning Grant Program (PGP). These and other FAA programs were funded from a newly-established Airport and Airway Trust Fund, modeled after the successful Highway Trust Fund, into which were deposited revenues from several aviation user taxes on such items as airline tickets, air freight and aviation fuel. The user-supported Trust Fund ended the need for airports and the air traffic control system to compete with other national priorities for appropriations from the General Fund. From Fiscal Years 1970 through 1980, approximately $4.2 billion (in current year dollars) was invested at 2,724 airports through ADAP grants and $100 million in PGP studies (see Table II-1 in Chapter II for further detail). The Act, after several amendments and a one-year extension, expired on September 30, 1981. During FY 1981 and FY 1982 the taxing provisions of the Trust Fund were reduced and revenues were deposited in the General Fund and the Highway Trust Fund. Congress continued, however, to appropriate airport aid - $450 million each for FY 1981 and FY 1982 (see Chapter II for further detail).

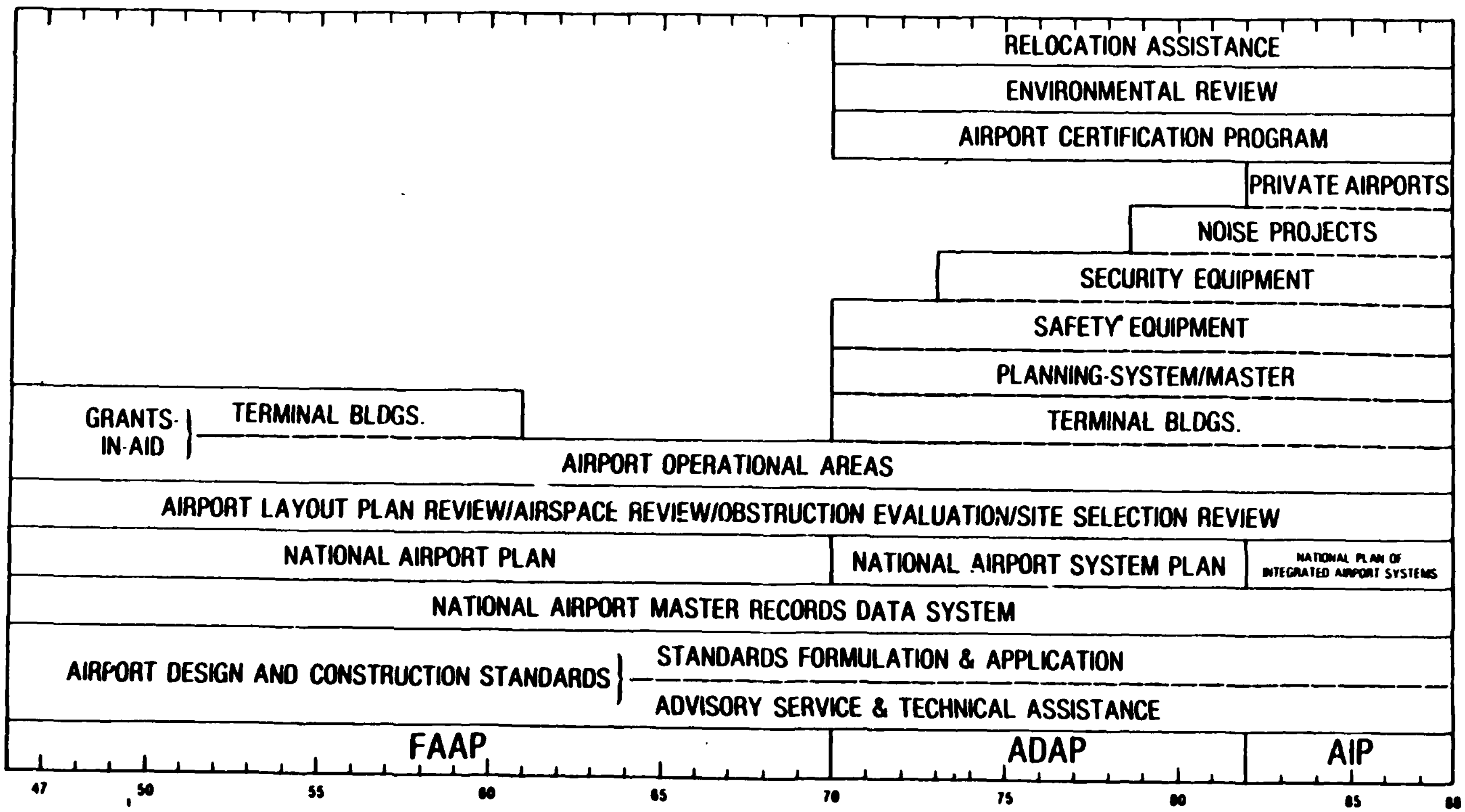
5. <u>Airport and Airway Improvement Act of 1982</u>

Congress did not agree on reauthorizing legislation until passage of the Airport and Airway Improvement Act of 1982 (P.L. 97-248, September 1982). The 1982 Act reestablished the operation of the Airport and Airway Trust Fund and authorized the current airport grant program, the AIP, a single program for airport planning and development. Overall, the 1982 Act and its amendments authorizes a total of nearly $4.99 billion (current year dollars) for FY 1982 through FY 1987 (excluding $.275 billion as authorized by the Surface Transportation Assistance Act (STAA) of 1982). The Act has been amended twice. The Continuing Appropriation Act of 1982 (P.L. 97-276, October 1982) added authority to issue discretionary grants in lieu of unused appropriated funds under certain circumstances, and the Surface Transportation Assistance Act of 1982 (P.L. 97-424, January 1983) provided for additional authorizations for FY 1983, 1984, and 1985.

Figure I-2 depicts the various functions legislated by the three major airport grant program authorization acts since 1946: FAAP, ADAP and AIP. The investments funded by these programs, as well as state and local shares of public spending on airports, is the subject of Chapter II which follows.

FIGURE I-2

Airport Programs - Legislated Program Functions, Fiscal Years 1947 through 1987



Source: Reproduced from Reference 6.

CHAPTER II - AIP AND RELATED U.S. AIRPORT SYSTEM INVESTMENT

A. INTRODUCTION

This chapter outlines the annual federal capital and planning investment in the U.S. airport system since 1947 under airport grant programs and the corresponding state and local shares for capital and planning investments and recurring operations and maintenance costs. The information provided here serves as the cost basis for the benefit/cost assessment presented in Chapter VII of this report.

Because there is a lack of precise and comprehensive information about airport finances and because airports are owned or managed by thousands of public agencies with varying bookkeeping practices, some of the data presented in this chapter are estimates obtained from a number of desparate sources, including References 1, 5, 6, 8, 9, 10, 11, and 12.

B. ANNUAL INVESTMENT IN AIRPORTS ASSOCIATED WITH FEDERAL GRANT PROGRAMS, FY 1947 - FY 1981

Table II-1 outlines annual federal, state, and local capital and planning spending on airports associated with federal airport grant programs since FY 1947. From FY 1947 through FY 1981, it is estimated that such investment totaled $8.2 billion (or $17.6 billion in constant 1985 dollars), of which the federal share accounted for $5.9 billion (or $11.7 billion in constant 1985 dollars) or about two thirds.

C. ANNUAL INVESTMENT IN AIRPORTS ASSOCIATED WITH FEDERAL GRANT PROGRAMS, FY 1981 - FY 2005

The annual federal authorization levels for the AIP and the companion Surface Transportation Assistance Act (STAA) of 1982, as well as the state/local investment shares and life-cycle support costs, are outlined in Table II-2 (in current year dollars) and Table II-3 (in 1985 constant and 1985 discounted present value dollars). The 1985 present value subtotals in Table II-3 are those which are carried forward to Chapter VII of this report in which the overall benefit/cost assessment is made. Aside from the STAA, approximately 89.5 percent of these investments are allocable to the airside benefits quantified in this report.

TABLE II-1

Annual Capital & Planning Investment Funded by Federal Airport Grant Programs and Complimenting State/Local Shares, FY 1947 - FY 1987 a/

(Amounts based on obligating authority, appropriations and authorizations, as indicated by footnotes)

Billions of Current Year Dollars

Fiscal Year	Federal Airport Grant Programs: FAAP b/	ADAP b/	PGP c/	AIP d/	Total	State/Local Shares e/	Total	Total (Billions '85 Dollars /f
1947	0.0428				0.0428	0.0428	0.0855	0.3917
1948	0.0305				0.0305	0.0305	0.0610	0.2612
1949	0.0370				0.0370	0.0370	0.0740	0.3200
1950	0.0365				0.0365	0.0365	0.0731	0.3097
1951	0.0212				0.0212	0.0212	0.0424	0.1686
1952	0.0159				0.0159	0.0159	0.0317	0.1242
1953	0.0103				0.0103	0.0103	0.0206	0.0793
1954	0.0000				0.0000	0.0000	0.0000	0.0000
1955	0.0208				0.0208	0.0208	0.0415	0.1548
1956	0.0625				0.0625	0.0625	0.1250	0.4519
1957	0.0630				0.0630	0.0630	0.1260	0.4405
1958	0.0630				0.0630	0.0630	0.1260	0.4331
1959	0.0630				0.0630	0.0630	0.1260	0.4231
1960	0.0630				0.0630	0.0630	0.1260	0.4163
1961	0.0630				0.0630	0.0630	0.1260	0.4125
1962	0.0750				0.0750	0.0750	0.1500	0.4822
1963	0.0750				0.0750	0.0750	0.1500	0.4751
1964	0.0750				0.0750	0.0750	0.1500	0.4679
1965	0.0750				0.0750	0.0750	0.1500	0.4579
1966	0.0750				0.0750	0.0750	0.1500	0.4436
1967	0.0710				0.0710	0.0710	0.1420	0.4077
1968	0.0660				0.0660	0.0660	0.1320	0.3630
1969	0.0700				0.0700	0.0700	0.1400	0.3661
1970		0.0300	0.0000		0.0300	0.0100	0.0400	0.0993
1971		0.1700	0.0100		0.1800	0.0667	0.2467	0.5832
1972		0.2800	0.0150		0.2950	0.1083	0.4033	0.9155
1973		0.2800	0.0150		0.2950	0.1083	0.4033	0.8657
1974		0.3000	0.0000		0.3000	0.1000	0.4000	0.7889
1975		0.3399	0.0000		0.3399	0.1133	0.4532	0.8178
1976+TQ		0.4375	0.0030		0.4405	0.0782	0.5187	0.8896
1977		0.5450	0.0150		0.5600	0.1012	0.6612	1.0716
1978		0.5400	0.0140		0.5540	0.1000	0.6540	0.9868
1979		0.6290	0.0150		0.6440	0.1622	0.8063	1.1198
1980		0.6400	0.0100		0.6500	0.1163	0.7663	0.9748
1981		0.4500			0.4500	0.0794	0.5294	0.6143
1982				0.4500	0.4500	0.1264	0.5764	0.6309
1983				0.8000	0.8000	0.1686	0.9686	1.0210
1984				0.9935	0.9935	0.2094	1.2029	1.2223
1985				0.9870	0.9870	0.2385	1.2255	1.2255
1986				1.0170	1.0170	0.2457	1.2627	1.2446
1987				1.0172	1.0172	0.2675	1.2847	1.2447
Total	1.1744	4.6414	0.0970	5.2647	11.1775	3.5744	14.7518	24.1664

a/ Values may not add to printed totals due to independent rounding.

b/ Sources: References 8 and 9. Amounts based on obligating authority.

c/ Source: Reference 8. Amounts based on appropriations.

d/ Source: Reference 6. Amounts based on annual authorizations. Includes federal Basic AIP and STAA funds. See Tables II-2 and II-3 for further detail.

e/ Source: FAA-APO-220 analysis of References 5, 6, 9 and 10. Based on following aggregate state/local participation percentages: FY69 and earlier - 50%; FY70-FY75 - 25% development, 50% planning; FY76&TQ-FY78 - 15% development; 25% planning; FY79 - 20% development, 25% planning; FY80-FY81 - 15% development, 25% planning; FY82-FY85 - from Table II-2; FY86-FY87 - proportional analogy with FY85.

f/ Adjusted to 1985 dollars via the G.N.P. Implicit Price Deflator. See Appendix D.

TABLE II-2

Federal and State/Local AIP Investment Shares (FY1982-FY1985) and Associated Recurring Support Costs (FY1983-FY2005)

(Billions of Current Year Dollars)

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)
	Federal Shares by Legislative Appropriation a/											State/Local Shares			
	Basic AIP Authorization														
Fiscal Year	Primary Airports	G.A. Airports	Reliever Airports	Non-Primary Comm'l. Service	Noise Compat-ibility	Integrated Airport System Planning	Alaskan Airports Provision	Discre-tionary Funds	Total (B..I)	STAA Funds	Total (J + K)	Capi-tal b/	Support (Opns & Maint) c/	Total (M + N)	Total (L + O)
1982	0.2250	0.0540	0.0450	0.0248	0.0360	0.0045	0.0138	0.0469	0.4500	0.0000	0.4500	0.1264		0.1264	0.5764
1983	0.3000	0.0720	0.0600	0.0330	0.0480	0.0060	0.0125	0.0685	0.6000	0.2000	0.8000	0.1686	0.0517	0.2203	1.0203
1984	0.3540	0.0952	0.0794	0.0436	0.0635	0.0079	0.0125	0.1374	0.7935	0.2000	0.9935	0.2094	0.1206	0.3300	1.3235
1985	0.4000	0.1094	0.0912	0.0502	0.0730	0.0091	0.0125	0.1666	0.9120	0.0750	0.9870	0.2385	0.2106	0.4491	1.4361
1986													0.3138	0.3138	0.3138
1987													0.3185	0.3185	0.3185
1988													0.3233	0.3233	0.3233
1989													0.3281	0.3281	0.3281
1990													0.3331	0.3331	0.3331
1991													0.3381	0.3381	0.3381
1992													0.3431	0.3431	0.3431
1993													0.3483	0.3483	0.3483
1994													0.3535	0.3535	0.3535
1995													0.3588	0.3588	0.3588
1996													0.3642	0.3642	0.3642
1997													0.3696	0.3696	0.3696
1998													0.3752	0.3752	0.3752
1999													0.3808	0.3808	0.3808
2000													0.3865	0.3865	0.3865
2001													0.3923	0.3923	0.3923
2002													0.3982	0.3982	0.3982
2003													0.3922	0.3922	0.3922
2004													0.3864	0.3864	0.3864
2005													0.3806	0.3806	0.3806
Total	1.2790	0.3306	0.2756	0.1516	0.2205	0.0275	0.0513	0.4194	2.7555	0.4750	3.2305	0.7428	7.5675	8.3103	11.5408

a/ Sources: References 5, 6, 9 and 10, except 1985 amounts for primary airports, integrated airport system planning, Alaskan Airport Provision, and discretionary funds which are FAA-APO-220 estimates.

b/ Derived by summing inverses of federal participation percentages applied to corresponding dollar amounts, where the assumed overall federal participation rates by column are: 70% for Column B; 90% for Columns C, D, E, G, H and I; 80% for Column F; and 100% for Column K.

c/ Annual recurring support costs for 1983 - 1986 based on: 69% (estimated portion of annual investment requiring recurring support) x 13% (representative ratio of annual support costs to initial investment) x Cumulative investment from 1982. Years subsequent to 1985 are assumed to increase @ 1.5% annually.

TABLE II-3

Federal and State/Local AIP Investment Shares (FY1982-FY1985) and Associated Recurring Support Costs (FY1983-FY2005) a/

(Billions of Constant 1985 $ and Constant 1985 $ at 1985 Present Value, as indicated)

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)
		Federal Shares by Legislative Appropriation																
		Basic AIP Authorization											State/Local Shares					
Fiscal Year	G.N.P. I.P.D. b/	Primary Airports	G.A. Airports	Reliever Airports	Non-Primary Comm'l. Service	Noise Compat-ibility	Integrated Airport System Planning	Alaskan Airports Provision	Discre-tionary Funds	Total (C..J)	STAA Funds	Total (K + L)	Capi-tal	Support (Opns & Maint)	Total (N + O)	Total (M + P)	1985 Present Value Factor c/	Total Present Value (1985$)
1982	207.38	0.2463	0.0591	0.0493	0.0271	0.0394	0.0049	0.0151	0.0513	0.4925	0.0000	0.4925	0.1384		0.1384	0.6309	1.331	0.8397
1983	215.34	0.3162	0.0759	0.0632	0.0348	0.0506	0.0063	0.0132	0.0722	0.6324	0.2108	0.8432	0.1777	0.0545	0.2322	1.0754	1.210	1.3013
1984	223.38	0.3597	0.0967	0.0807	0.0443	0.0645	0.0080	0.0127	0.1396	0.8063	0.2032	1.0095	0.2127	0.1226	0.3353	1.3448	1.100	1.4793
1985	226.98	0.4000	0.1094	0.0912	0.0502	0.0730	0.0091	0.0125	0.1666	0.9120	0.0750	0.9870	0.2385	0.2106	0.4491	1.4361	1.000	1.4361
1986	230.28													0.3093	0.3093	0.3093	0.909	0.2812
1987	234.28													0.3086	0.3086	0.3086	0.826	0.2550
1988	238.78													0.3073	0.3073	0.3073	0.751	0.2309
1989	243.18													0.3063	0.3063	0.3063	0.683	0.2092
1990	247.88													0.3050	0.3050	0.3050	0.621	0.1894
1991	253.08													0.3032	0.3032	0.3032	0.564	0.1711
1992	258.58													0.3012	0.3012	0.3012	0.513	0.1546
1993	264.08													0.2993	0.2993	0.2993	0.467	0.1396
1994	269.58													0.2976	0.2976	0.2976	0.424	0.1262
1995	275.28													0.2958	0.2958	0.2958	0.386	0.1141
1996	281.08													0.2941	0.2941	0.2941	0.350	0.1031
1997	286.98													0.2924	0.2924	0.2924	0.319	0.0932
1998	292.88													0.2908	0.2908	0.2908	0.290	0.0842
1999	298.68													0.2894	0.2894	0.2894	0.263	0.0762
2000	304.48													0.2881	0.2881	0.2881	0.239	0.0690
2001	310.28													0.2870	0.2870	0.2870	0.218	0.0625
2002	315.98													0.2860	0.2860	0.2860	0.198	0.0566
2003	321.68													0.2852	0.2852	0.2852	0.180	0.0513
2004	327.38													0.2844	0.2844	0.2844	0.164	0.0465
2005	333.18													0.2837	0.2837	0.2837	0.149	0.0422
Total (85$)		1.3222	0.3411	0.2844	0.1564	0.2275	0.0284	0.0535	0.4297	2.8433	0.4890	3.3323	0.7673	6.3024	7.0697	10.4020		7.6123
Total (85$ @ Present Value)		1.5061	0.3863	0.3220	0.1771	0.2576	0.0321	0.0625	0.4759	3.2197	0.5536	3.7733	0.8716	2.9673	3.8390	7.6123		

a/ Source: Corresponding amounts from Table II-2 multiplied by ratio of implicit price deflator in 1985 to that for current year.

b/ Gross National Product Implict Price Deflator (see Appendix D).

c/ Present value factors based on 10% discount rate as viewed from 1985. See Appendix C.

CHAPTER III - CATEGORIZATION AND SUMMARY OF BENEFITS

A. INTRODUCTION

This chapter describes and summarizes the benefits encompassed in this report--those major airside life-cycle benefits that have accrued and that are expected to accrue from investments made under the AIP from FY 1982 through FY 1985 inclusively. The "Declaration of Policy" expressed in the legislation authorizing the AIP - the Airport and Airway Improvement Act of 1982 - is outlined and a list of AIP and work projects aimed at fulfilling these policies is provided.

As pointed out earlier, while the study centers on the AIP, its findings and conclusions generally apply to airport airside investments from other funding sources as well, e.g., state and local funding. It is again stressed that because not all types of benefits are quantified, the analysis should be considered conservative in that it probably understates total investment impact.

B. LEGISLATIVE POLICY

In formulating the Airport and Airway Improvement Act, the Congress included a "Declaration of Policy." This legislative policy was used to bound the benefits encompassed in this report, and is outlined below as a basis upon which to assess the alignment of AIP goals, objectives and work projects (numeric identification not in Act but rather for convention of this report only):

1. The safe operation of the airport and airway system will continue to be the highest aviation priority.

2. The continuation of airport and airway improvement programs and more effective management and utilization of the Nation's airports are required to meet the current and projected growth of aviation and the requirements of interstate commerce, the Postal Service and the National defense.

3. The Act should be administered in a manner to provide adequate navigation aids and airport facilities, including reliever airports and reliever heliports, for points where scheduled commercial service is provided.

4. The Act should be administered in a manner consistent with a comprehensive airspace system plan to maximize the use of safety facilities, with highest priority for commercial service airports, including but not limited to, the goal of installing, operating, and maintaining, to the extent possible under available funds and given other safety needs, a precision approach system and a full approach light system for all primary and secondary runways, a nonprecision instrument approach for all secondary runways, runway edge lighting and marking, and radar approach coverage for all airport terminal areas (Note: the FAA's Facilities and Equipment Appropriation provides funding for certain airport facilities and equipment meeting published establishment criteria (Reference 13) that are not included under airport development grants.)

5. The Act should be administered in a manner consistent with the Federal Aviation Act of 1958 with due regard for the goals expressed therein of fostering competition, preventing unfair competition in air transportation, maintaining essential air transportation and preventing unjust and discriminatory practices.

6. Special emphasis should be given to reliever airports and their development.

7. Aviation facilities should be constructed and operated with due regard to minimizing current and projected noise impacts on nearby communities.

8. The Federal administrative requirements placed upon airport sponsors can be reduced and simplified through the use of a single project application to cover all airport improvement projects to be undertaken in a particular year.

9. It is in the national interest to develop in metropolitan areas an integrated system of airports designed to provide expeditious access and maximum safety.

C. DESCRIPTION AND SUMMARY OF BENEFITS

Based on the legislative policy outlined above, three categories of benefits were identified and analyzed: safety, capacity and environmental protection, and economic development. One chapter is devoted to each category. While benefits are estimated by type, airport capital investments generally generate more than one type of benefit. A condensed tabular summary of the quantified benefits is given in Table III-1. For purposes of overview, each benefit category is briefly described below along with a summary of the findings. For purposes of benefits organization and quantification, AIP goals, objectives and projects are compiled and aligned in Table III-2 with the legislative policies set forth in the Act.

TABLE III-1

Summary of Life-Cycle Benefits
(1985 Dollars at 1985 Discounted Present Value)

	Benefit Valuation		
Benefit Category	Federal	State/Local	Total
Safety, Capacity, Environmental Protection	$ 4.33	$5.16	$9.48
Economic Development	7.20	8.59	15.79
Total	$11.53	$13.75	$25.28

1. Safety, Capacity, and Environmental Protection Benefits

The FAA's main mission is to promote aviation safety. In its pursuit of maintaining and improving safety, the FAA provides air traffic control services, safety regulations and enforcement, installs facilities and equipment under its Facilities and Equipment Appropriation, and provides federal grant-in-aid funding under the AIP Appropriation. These programs, in conjunction with aviation safety activities of other Government agencies as well as the aviation industry itself, have contributed to an impressive aviation safety record which serves as a benchmark for the rest of the world.

Safety benefits of the AIP are realized by the following AIP goals and objectives:

Increase safety of aircraft operations at airports by bringing airports up to design standards or replacing existing substandard airports or airport facilities.

Increase safety of aircraft operations by increasing safety margins.

Increase safety of aircraft operations by insuring rapid response by adequate crash/fire/rescue facilities to minimize loss of life, injury and property damage in the event of aircraft accidents.

Increase security of aircraft operations by preventing unauthorized or hazardous access to aircraft operating areas.

A major concern of airport users and aircraft operators is delay. Aircraft operations sometimes cannot be performed on schedule because of the queue of aircraft awaiting their turn for takeoff, landing, or use of taxiways and gates. These delays translate into wasted time for passengers and increased operating costs for aircraft operators. The cause for this delay is commonly referred to as a "lack of capacity," meaning that the airport does not have facilities such as runways, taxiways, or gates in sufficient quantity to accommodate efficiently all those who want to use the airport at peak periods of demand. Solutions generally advocated include providing additional capital facilities, making more efficient and effective use of existing facilities, and channelling traffic to offpeak time periods or to alternate airports.

Capacity benefits of the AIP are realized by the following AIP goals and objectives.

Provide adequate community or metropolitan area airport system airside capacity to minimize congestion and delay of current and forecast aircraft operations (i.e., increase normal, peak hour airport or airport system airside capacity); includes expanded aircraft parking facilities.

Provide adequate community or metropolitan area airport system ground access and passenger terminal building capacity to minimize passenger landside access time, congestion and delay.

Upgrade existing airports to serve larger and more demanding aircraft.

Preserve or improve the usefulness and maintainability of existing airport airside facilities through repair or reconstruction.

Increase airport usability by aircraft under varying conditions of weather and darkness.

Provide air access or improve air access reliability to communities or remote areas of national interest through establishment of additional or replacement airports where justified.

Reduce energy requirements of airport operations by increasing operating efficiency where cost beneficial.

Aviation noise is a fact of life at today's airports and in some cases a major constraint on airport utilization, expansion and development. Conflicts between airports and their neighbors have occurred since the early days of aviation, but conflicts over noise became a more serious issue with the introduction of jet aircraft in the 1960's. Citizens living in and around airports and their approach departure paths have complained that aviation noise is annoying, disturbs sleep, interferes with conversation, and generally detracts from the enjoyable use of property. Airport noise has become a major political issue in certain communities.

Environmental benefits of the AIP are realized by the following AIP goals and objectives:

In carrying out necessary airport development, restore or enhance environmental quality to the fullest extent practicable. Make a special effort to preserve the natural beauty of the countryside, public parks and recreation lands, wildlife and waterfowl refuges, historic sites, and the nation's coastal zone.

Reduce to a minimum the adverse impact of noise generated by aircraft operations at airports.

Based on the analysis in Chapters IV and V, the combined interdependent safety, capacity and environmental protection life-cycle benefits that have accrued and will accrue from AIP investments (including associated state/local shares and recurring operations and maintenance costs) from FY 1982 through FY 1985 are estimated to be $9.48 billion (1985 dollars at discounted present value). Of this total, the federal share is $4.33 billion.

2. Economic Development Benefits

While economic development is not a direct goal or objective of the AIP, it is a corollary benefit which flows from any economic activity. Aviation has done much to shape our economy. It is a major

determinant of how the nation conducts its business affairs. The size of corporations, the dimensions of their marketing, their investment in plant, equipment and inventory and even their organization charts are influenced by the ability to sell, manage, and ship by air. Airports, being at core of aviation, are essential components in many regional economies and are often impressive industries in their own rights.

Based on the analysis in Chapter VI, the economic development benefits that have accrued and will accrue from AIP airside investments from FY 1982 through FY 1985 are estimated to be $15.79 billion (1985 dollars at discounted present value). Of this total, the federal share is $7.20 billion.

TABLE III-2

Categorization of Benefits Vis-A-Vis AIP Projects And Legislative Policy

WORK CODE	AIP PROJECT DESCRIPTION	Legislative Policies to Which Aligned (References are to Section B of this Chapter)	Benefit Categories: Safety (Chapter IV)	Capacity / Environment (Chapter V)		Economic Development (Chapter VI)
	PLANNING					
A01	Master Planning	1,2, 6, 9	X	X		X
A02	State System Planning	1,2, 6, 9	X	X		X
A03	Metropolitan System Planning	1,2, 6, 9	X	X		X
A04	Regional System Planning	1,2, 6, 9	X	X		X
A05	Noise Compatibility Planning	1,2, 7,9	X	X	X	X
A09	Miscellaneous Planning	1,2, 6, 9	X	X		X
	GENERAL SAFETY					
B01	Crash/Fire/Rescue (CFR) Vehicle	1, 3,4, 9	X			X
B02	Safety Related Buildings (CFR, CFR/ Maintenance Equipment, etc.)	1, 3,4, 9	X			X
B03	Obstruction Removal, Marking and/or Lighting	1,2,3,4, 9	X	X		X
B09	Miscellaneous Safety Improvements	1, 3,4, 9	X			X
	SECURITY (PART 107 REQUIREMENTS ONLY)					
C01	Security Improvements	1, 3,4, 9	X			
	RUNWAYS					
D01	Runway Construction	1,2, 6, 9	X	X		X
D02	Runway Improvements (Excluding Friction Treatment)	1,2, 9	X	X		X
D03	Runway Extension	1,2, 6, 9	X	X		X
D04	Runway Grooving	1,2, 9	X	X		X
D05	Runway Friction Treatment	1,2, 9	X			X
D06	Runway Seal Coat	2, 9		X		X
D08	Runway Development for Noise Compatibility	9		X	X	X
D09	Miscellaneous Runway Improvements	1,2, 9	X	X		X

TABLE III-2 (Cont'd)

Categorization of Benefits Vis-A-Vis AIP Projects And Legislative Policy

WORK CODE	AIP PROJECT DESCRIPTION	Legislative Policies to Which Aligned (References are to Section B of this Chapter)	Benefit Categories: Safety (Chapter IV)	Capacity / Environment (Chapter V)		Economic Development (Chapter VI)
	TAXIWAYS					
E01	Taxiway Construction	1,2, 6, 9	X	X		X
E02	Taxiway Improvements	1,2, 9	X	X		X
E03	Taxiway Extension	1,2, 6, 9	X	X		X
E06	Taxiway Seal Coat	2, 9		X		X
E08	Taxiway Development for Noise Compatibility	2, 7,9		X	X	X
E09	Other	1,2, 9	X	X		X
	APRONS					
F01	Apron Construction	1,2, 6, 9	X	X		X
F02	Apron Improvements	1,2, 9	X	X		X
F03	Apron Expansion	1,2, 6, 9	X	X		X
F06	Apron Seal Coat	2, 9		X		X
F09	Miscellaneous Apron Improvements	1,2, 9	X	X		X
	LIGHTING					
G01	High Intensity Runway Lighting	1,2,3,4,6, 9	X	X		X
G02	Medium Intensity Runway Lighting	1,2,3,4,6, 9	X	X		X
G03	Runway Centerline Lighting	1,2,3,4,6, 9	X	X		X
G04	Rehabilitate Runway Lighting	1,2,3,4,6, 9	X	X		X
G05	Rehabilitate Taxiway Lighting	1,2,3,4,6, 9	X	X		X
G08	Lighting for Noise Compatibility	7,9		X	X	X
G09	Miscellaneous Lighting Improvements	1,2,3,4,6, 9	X	X		X
	NAVAIDS					
H01	Instrument Approach Aid	1,2,3,4,6, 9	X	X		X
H02	Partial Instrument Approach Aid	1,2,3,4,6, 9	X	X		X
H03	Visual Approach Aid	1,2,3,4,6, 9	X	X		X
H08	NAVAIDS for Noise Compatibility	3,4, 7,9		X	X	X
H09	Miscellaneous NAVAIDS Improvements	1,2,3,4,6, 9	X	X		X

TABLE III-2 (Cont'd)

Categorization of Benefits Vis-A-Vis AIP Projects And Legislative Policy

WORK CODE	AIP PROJECT DESCRIPTION	Legislative Policies to Which Aligned (References are to Section B of this Chapter)	Benefit Categories: Safety (Chapter IV)	Benefit Categories: Capacity / Environment (Chapter V)	Benefit Categories: Economic Development (Chapter VI)
	WEATHER EQUIPMENT				
I01	Snow Removal Equipment	1,2,3,4,6	X	X	X
I02	Runway Sensors	1,2,3,4,6	X	X	X
I03	Weather Reporting Equipment	1,2,3,4,6	X	X	X
I04	Taxiway Sensors	1,2,3,4,6	X	X	X
I09	Miscellaneous Weather Equipment Improvements	1,2,3,4,6	X	X	X
	TERMINAL DEVELOPMENT				
J01	Terminal Building Construction	2,3, 6, 9		X	X
J02	Terminal Building Improvements	2,3, 6, 9		X	X
J03	Terminal Building Expansion	2,3, 6, 9		X	X
J04	Terminal Building Bond Retirement	2, 9			X
J09	Miscellaneous Terminal Building Improvements	2,3, 9		X	X
	BUILDINGS (OTHER THAN SAFETY, SECURITY, OR TERMINAL DEVELOPMENT)				
K01	Building Construction	2,3, 6, 9		X	X
K02	Building Improvements	2,3, 6, 9		X	X
K09	Miscellaneous Building Improvements	2,3, 9		X	X
	ROADWAYS				
L01	Access Way Construction	2,3, 6, 9		X	X
L02	Access Way Improvements	2,3, 6, 9		X	X
L03	Service Road Construction	2,3, 6, 9		X	X
L04	Service Road Improvements	2,3, 6, 9		X	X
L09	Miscellaneous Roadway Improvements	2,3, 6, 9		X	X

TABLE III-2 (Cont'd)

Categorization of Benefits Vis-A-Vis AIP Projects And Legislative Policy

WORK CODE	AIP PROJECT DESCRIPTION	Legislative Policies to Which Aligned (References are to Section B of this Chapter)	Benefit Categories: Safety (Chapter IV)	Capacity / Environment (Chapter V): Capacity	Capacity / Environment (Chapter V): Environment	Economic Development (Chapter VI)
	ADDITIONAL NOISE COMPATIBILITY					
M01	Noise Barrier	2,3, 7,9		X	X	X
M02	Landscaping to Reduce Noise	2, 7,9		X	X	X
M03	Noise Suppressing Equipment	2,3, 7,9		X	X	X
M04	Soundproofing	2, 7,9		X	X	X
M09	Miscellaneous Noise Control Measures	2,3, 7,9		X	X	X
	LAND					
N01	Land for Development	2, 6, 9		X		X
N02	Land for Approaches	2, 6, 9		X		X
N03	Land for Noise Compatibility	2, 7,9		X	X	X
N04	Relocation Assistance	2, 6, 9				X
N05	Relocation Assistance for Noise Compatibility	2, 7,9		X	X	X
N09	Miscellaneous Airport Land	2, 6, 9		X		X
	MISCELLANEOUS					
P01	Miscellaneous Airport Improvements	1,2,3,4,6,7,9	X	X	X	X
	ACQUIRE AIRPORT					
R01	Partial Acquisition	2, 6, 9		X		X
R02	Complete Initial or Final Phase Acquisition	2, 6, 9		X		X

CHAPTER IV - SAFETY BENEFITS

A. INTRODUCTION

The FAA's main mission is to promote aviation safety. Within the scope of AIP goals and objectives, the FAA helps airport sponsors fund several varied safety-related projects. These types of projects were outlined in Table III-2 of Chapter III. This chapter derives a gross "least-case" estimate of the life-cycle airside safety benefits that have accrued and that are projected to accrue from investments under the AIP from FY 1982 through FY 1985 inclusively. While the focus of the analysis is on the AIP, the findings and conclusions can generally be postulated also for airside safety investments from other airport funding sources as well, e.g., non-AIP state and local funding.

B. OVERVIEW OF SCOPE, METHODOLOGY AND ORGANIZATION

A "reasonable man" approach was taken in this effort of estimating the "least-case" benefits accruing from safety-related investments under the AIP. The approach consists of four steps, as summarized below:

- Identification and isolation of pertinent historic aircraft accident data for what are termed "AIP-mitigated" accidents -- those accidents that occurred in an "airport environment" whose incidence and extent of attendant losses in totality could have been directly or indirectly reduced by the existence or presence of airport investments characteristic of those funded under the AIP.

- Estimation of the monetary losses associated with "AIP-mitigated" accidents using FAA standard unit monetary benefit values.

- Selection and presentation of historic and forecast annual airport activity measures by which to denominate annual "AIP-mitigated" accident costs to a cost per unit of activity.

- Projection of the life-cycle safety benefits that have accrued and that will accrue from expenditures under the AIP from FY 1982 through FY 1985, based on a time series analysis of the annual historic costs of "AIP-mitigated" accidents and annual aircraft activity.

C. AIRCRAFT ACCIDENT DATA

1. Introduction

As a basis for estimating the impact of AIP investments on airport safety, selected annual aircraft accident data over a study period extending from CY 1970 through CY 1981 were examined. After considering the entire universe of civil aviation accidents over this study period as reported by the National Transportation Safety Board (NTSB), an "airport environment" accident subset and then, within this subset, an "AIP-mitigated" accident subset were isolated. "Airport environment" accidents are defined as those occurring in or about the environs of an airport in which the

aircraft involved were in either the static, taxi, takeoff or landing phase(s) of operation. "AIP-mitigated" accidents are defined as those "airport environment" accidents whose incidence or extent of attendant losses in total could have been directly or indirectly reduced by the existence or presence of investments characteristic of those funded under the AIP.

2. Total Accidents and "Airport Environment" Accidents

Table IV-1 presents the number and trend of U.S. air carrier and general aviation aircraft accidents over the CY 1970 - CY 1981 study period. To facilitate identification of the "airport environment" accident subset, Table IV-1 categorizes accidents by two operational phase groupings -- "inflight" and "other than inflight."1/ The "other than inflight" columns for general aviation are further categorized by "airport environment" and "other than airport environment." The latter category encompasses accidents involving gliders, balloons, and certain rotorcraft and other accidents that, although occurring in either the static, taxi, takeoff or landing phases of operation, may not have occurred in an actual airport environment. The "Other Than Inflight" (for air carrier) and "Other Than Inflight - Airport Environment" (for general aviation) columns thus constitute the "airport environment" accident subset.

3. The "AIP-Mitigated" Accident Subset

Having identified "airport environment" accidents, the next step is to isolate that subset which is "AIP-mitigated," (i.e., those accidents occurring in the "airport environment" whose incidence or extent of attendant losses might have been directly or indirectly reduced by the existence or presence of investments characteristic of those funded under the AIP). This was accomplished by isolating those accidents for which the cited probable cause(s)2/ and factor(s)3/ were

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1/ The phase of operation, categorized by the NTSB as static, taxi, takeoff, inflight and landing, relates to the particular segment of the flight or operation during which the first accident type or circumstances of the accident occurred.

2/ Probable Cause(s) - "Condition(s) and/or event(s), or the collective sequence of conditions and/or events, that the collective sequence of conditions and/or events, that most probably caused the accident to occur. Had the conditions and/or events been omitted from the sequence the accident would not have occurred."

3/ Factor(s) - "Related condition(s) or event(s) which existed or occurred coincident with the condition(s) and/or event(s) that most probably caused an accident but which may or may not have contributed significantly to the accident. The omission of a factor(s) from the occurrence would not necessarily have prevented the accident".

TABLE IV-1

Total Accidents and Airport Environment Accidents a/

Calendar Year c/	No. Accidents Involving U.S. Air Carrier Aircraft: In-flight	O/T In-flight d/	Unk	Total	No. Accidents Involving U.S. General Aviation Aircraft: In-flight	O/T Inflight: Airport Environment d/	O/T Inflight: Other Than Airport Environment	Sub-Total	Unk	Total	Total No. Accidents Involving U.S. Civil Aviation Aircraft b/: In-flight	O/T Inflight: Airport Environment No.	Airport Environment % of Total	Other Than Airport Environment	Sub-Total	Unk	Total
1981 : Air Carrier																	
Part 121	9	17	0	26							9	17	65%		17	0	26
Part 135	52	134	2	188							52	134	71%		134	2	188
Gen. Aviation					1,256	1,655	566	2,221	25	3,502	1,256	1,655	47%	566	2,221	25	3,502
Total	61	151	2	214	1,256	1,655	566	2,221	25	3,502	1,317	1,806	49%	566	2,372	27	3,716
1980 : Air Carrier																	
Part 121	7	12	0	19							7	12	63%		12	0	19
Part 135	64	144	0	208							64	144	69%		144	0	208
Gen. Aviation					1,230	1,665	672	2,337	30	3,597	1,230	1,665	46%	672	2,337	30	3,597
Total	71	156	0	227	1,230	1,665	672	2,337	30	3,597	1,301	1,821	48%	672	2,493	30	3,824
1979	8	23	1	32	1,392	1,937	653	2,590	41	4,023	1,400	1,960	48%	653	2,613	42	4,055
1978	9	15	0	24	1,514	2,216	720	2,936	44	4,494	1,523	2,231	49%	720	2,951	44	4,518
1977	13	13	0	26	1,451	2,090	714	2,804	31	4,286	1,464	2,103	49%	714	2,817	31	4,312
1976	10	18	0	28	1,469	2,100	608	2,708	16	4,193	1,479	2,118	50%	608	2,726	16	4,221
1975	17	28	0	45	1,440	2,110	642	2,752	45	4,237	1,457	2,138	50%	642	2,780	45	4,282
1974	23	23	1	47	1,433	2,270	693	2,963	29	4,425	1,456	2,293	51%	693	2,986	30	4,472
1973	20	23	0	43	1,418	2,192	617	2,809	28	4,255	1,438	2,215	52%	617	2,832	28	4,298
1972	18	32	0	50	1,342	2,266	618	2,884	30	4,256	1,360	2,298	53%	618	2,916	30	4,306
1971	22	26	0	48	1,411	2,588	625	3,213	24	4,648	1,433	2,614	56%	625	3,239	24	4,696
1970	20	35	0	55	1,401	2,621	660	3,281	30	4,712	1,421	2,656	56%	660	3,316	30	4,767
Total	292	543	4	839	16,757	25,710	7,788	33,498	373	50,628	17,049	26,253	51%	7,788	34,041	377	51,467

a/ Source: FAA-APO-220 analysis of References 15 and 16.

b/ Totals, as printed, may be slightly overstated due to accidents involving collisions between air carrier and general aviation aircraft.

c/ In 1980 and 1981, accidents involving revenue operations of Commuter Air Carriers and On Demand Air Taxis were reported by the NTSB in annual reviews of air carrier accidents. In 1979 and prior years, such accidents were reported in annual reviews of general aviation accidents. In 1975 and later years, U.S. air carrier statistics include commercial operators of large aircraft. In 1975 and prior years, such accidents were reported in annual reviews of general aviation accidents.

deemed (for purposes of this analysis) to be "AIP-mitigated" (i.e., those accident cause and factor citations whose frequency of citation in total should conceptually be reduced by the infusion of airport investments characteristic of those funded under the AIP). Factors, as well as causes, were considered because factors can impact the "degree" of damage, given an accident which occurred by definition because of the cited cause(s).

For purposes of isolating the "AIP-mitigated" accident subset, the NTSB accident cause/factor classification system was screened to identify in a pro-forma fashion specific causes/factors which might be postulated as those whose frequency of citation in total might have been reduced by the existence or presence of AIP safety-related investments. Selected examples of aligned AIP safety-related investments and cause/factor citations are outlined in Table IV-2. The resulting number of "AIP-mitigated" citation classifications within each broad accident cause/factor category is outlined in Column D of Table IV-3. Their annual frequencies of occurrence, in total and relative to the annual frequency of all accident cause/factor citations, are summarized in Table IV-4. Their specific identity and annual frequencies of occurrence are outlined in detail in Appendices B-1 (for all aircraft operations), B-2 (for air carrier operations), and B-3 (for general aviation operations).

D. AIRCRAFT ACCIDENT COSTS

1. Introduction

This section derives the economic or monetary losses associated with the annual aircraft accident data outlined in Section C above. The FAA uses certain economic values, commonly referred to as "critical values," in its economic evaluation of investment and regulatory programs. The unit cost elements that are relevant in safety analyses (the unit costs of fatal and nonfatal injuries by type and degree and the unit costs of aircraft damage by type and degree) as well as other critical values used elsewhere in this report are outlined in Appendix A.

2. Total Accident Costs and "Airport Environment" Accident Costs

In the cases of the total accident and "airport environment" accident populations, the known numbers of injuries by degree and aircraft involved by type and degree of damage were costed using the critical values referred to above. The resulting annual accident cost estimates over the CY 1970 - CY 1981 study period are outlined in Sections A and B of Table IV-5 for all accidents and "airport environment" accidents respectively.

3. "AIP-Mitigated" Accident Costs

As a means of estimating the costs of the "AIP-aligned" accident subset, the following procedure was followed:

:ABLE IV-2

Selected Examples of Aligned AIP Safety Related Investments and Accident Cause/Factor Citations

AIP Safety-Related Investment	Aligned Cause/Factor Citation: Broad Category	Subcategory	Specific C/F
Obstruction removal, marking and lighting	Pilot	Pilot-in-Comd, Copilot, Dual Stud, Chk Pilot	Failed to see and avoid objects or obstructions
	Airport-Airways-Facilities	Airport Facilities	Obstruction lighting
	Airport-Airways-Facilities	Airport Conditions	Unmarked obstructions
	Personnel	Airport Supervisory Personnel	Failure to notify of unsafe condition and or failure to mark obstruction
Snow removal equipment	Personnel	Airport Supervisory Personnel	Improper, inadequate snow removal
	Airport-Airways-Facilities	Airport Conditions	Snow on runway
	Airport-Airways-Facilities	Airport Conditions	Snow on ramp, taxiway
	Weather	Snow	
Runway improvements	Airport-Airways-Facilities	Airport Conditions	Soft shoulders (runway)
Runway seal coat	Airport-Airways-Facilities	Airport Conditions	Soft runway
Misc. runway improvements	Airport-Airways-Facilities	Airport Conditions	Poorly maintained runway surface
Taxiway improvements	Airport-Airways-Facilities	Airport Conditions	Soft shoulders (ramp/taxiway)
Taxiway seal coat	Airport-Airways-Facilities	Airport Conditions	Soft taxiway
	Airport-Airways-Facilities	Airport Conditions	Poorly maintained taxiway
Runway lighting rehabiliatation	Airport-Airways-Facilities	Airport Facilities	Approach lighting
Taxiway lighting rehabiliatation	Airport-Airways-Facilities	Airport Facilities	Runway lighting
Miscellaneous lighting improvements	Airport-Airways-Facilities	Airport Facilities	Taxiway lighting and marking

Selected Examples of Aligned AIP Safety Related Investments and Accident Cause/Factor Citations

AIP Safety-Related Investment	Aligned Cause/Factor Citation		
	Broad Category	Subcategory	Specific C/F
Weather reporting equipment	Weather	Fog	
	Weather	Unfavorable wind conditions	
Runway sensors	Weather	High temperature	
Taxiway sensors	Weather	Low ceiling	
Miscellaneous weather equipment	Weather	Obstructions to vision (smoke, haze, sand and dust)	
	Weather	Rain	
	Weather	Wind shear	
	Weather	Sudden wind shift (takeoff or landing)	
	Weather	Local whirlwind	
	Weather	Downwind (landing or takeoff)	
	Personnel	Weather Personnel	Incorrect weather forecast
	Personnel	Weather Personnel	Inadequate weather forecast
	Personnel	Weather Personnel	Inadequate, incorrect weather briefing
	Personnel	Airport Supervisory Personnel	Inadequately maintained facilities
	Personnel	Airport Supervisory Personnel	Failure to advise of unsafe airport condition
	Personnel	Traffic Control Personnel	Excessive workload
	Personnel	Traffic Control Personnel	Failure to advise of unsafe weather condition
	Pilot	Pilot-in-Comd, Copilot, Dual Stud, Chk Pilot	Misjudged altitude
	Pilot	Pilot-in-Comd, Copilot, Dual Stud, Chk Pilot	Selected wrong runway relative to existing runway
	Airport-Airways-Facilities	Airport Conditions	Wet runway
	Airport-Airways-Facilities	Airport Conditions	Hydroplaning
Other	Personnel	Airport Supervisory Personnel	Improper maintenance of airport facilities
	Personnel	Airport Supervisory Personnel	Failure to advise of unsafe condition
	Miscellaneous	Animal(s) on runway, taxiway, ramp	

TABLE IV-3

Accident Cause/Factor Classifications

(A) Broad Cause/Factor Category a/	(B) Number of Major Sub-categories a/	(C) No. of Specific C/F Citations: Total a/	(D) No. of Specific C/F Citations: Number Deemed to be "AIP-Mitigated" b/
Pilot	4	66 c/	4 d/
Personnel	15	62	13
Airframe	4	42	0
Powerplant	31	237	0
Systems	10	74	0
Instruments/Equipment and Accessories	3	24	0
Rotorcraft	4	35	0
Airports/Airways/Facilities	3	33	23
Weather	0	23	16
Terrain	0	11	2
Miscellaneous	0	13	2
Miscellaneous Acts, Conditions e/	0	178	e/
Total	74	798	60

a/ Source: Reference 17.
b/ Detailed in Appendix B.
c/ 66 causes/factors are common to each of the four major subcategories. (pilot-in-command, co-pilot, student, and check pilot).
d/ 16 causes/factors are common to each of the four major subcategories. 13 of these are combined, for purposes of this analysis, into a single cause/factor grouping (misjudged distance and/or/speed and/or altitude and/or clearance), leaving 4 individual causes/factors.
e/ Not considered in this analysis.

TABLE IV-4

Summary of Cause/Factor Citation Frequency, 1970 - 1981 a/

Cause/Factor Citation Grouping	Calendar Year b/ 1981		1980		1979		1978		1977		1976		1975		1974		1973		1972		1971		1970	
	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F
A. "AIP-MITIGATED" C/F CITATIONS c/																								
Air Carrier	30	140	30	142	1	11	1	5	6	11	7	8	7	12	3	11	8	15	7	12	4	16	9	9
General Aviation	422	894	405	806	482	966	569	958	609	931	749	1017	670	1127	751	1187	853	1233	782	922	991	796	1066	770
Total	452	1034	435	948	483	977	570	963	615	942	756	1025	677	1139	754	1198	861	1248	789	934	995	812	1075	779
(% of Total C/F Citations)	8%	31%	8%	31%	8%	31%	8%	32%	8%	32%	9%	31%	8%	32%	9%	29%	10%	34%	10%	31%	12%	34%	12%	35%
B. ALL OTHER C/F CITATIONS d/																								
Air Carrier	316	136	324	119	44	11	45	16	47	8	40	8	73	25	78	20	59	17	78	4	78	12	80	17
General Aviation	4916	2185	5030	2029	5668	2132	6551	1991	6786	2017	7185	2228	7300	2449	7927	2872	7721	2393	7000	2072	7508	1566	7939	1451
Total	5232	2321	5354	2148	5712	2143	6596	2007	6833	2025	7225	2236	7373	2474	8005	2892	7780	2410	7078	2076	7586	1578	8019	1468
(% of Total C/F Citations)	92%	69%	92%	69%	92%	69%	92%	68%	92%	68%	91%	69%	92%	68%	91%	71%	90%	66%	90%	69%	88%	66%	88%	65%
C. TOTAL C/F CITATIONS d/																								
Air Carrier	346	276	354	261	45	22	46	21	53	19	47	16	80	37	81	31	67	32	85	16	82	28	89	26
(% of Total C/F Citations)	6%	8%	6%	8%	1%	1%	1%	1%	1%	1%	1%	0%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
General Aviation	5338	3079	5435	2835	6150	3098	7120	2949	7395	2948	7934	3245	7970	3576	8678	4059	8574	3626	7782	2994	8499	2362	9005	2221
(% of Total C/F Citations)	94%	92%	94%	92%	99%	99%	99%	99%	99%	99%	99%	100%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
Total	5684	3355	5789	3096	6195	3120	7166	2970	7448	2967	7981	3261	8050	3613	8759	4090	8641	3658	7867	3010	8581	2390	9094	2247

a/ Sources: For "Total C/F Citations," References 15 and 16. For "AIP-Mitigated" Citations, FAA-APO-220 analysis based in part on References 15 and 16.
b/ See Table IV-1, footnote c, regarding classification changes over time.
c/ See Appendix B for further detail.
d/ Excludes "Miscellaneous Acts, Conditions."

TABLE IV-5

Accident Cost Estimates (Millions of Constant 1982 Dollars) a/

	Calendar Year b/											
	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
A. ALL ACCIDENTS												
Air Carrier												
Aircraft Damage	69.4	67.1	108.1	54.0	56.8	67.9	108.0	79.1	92.3	113.6	179.4	120.0
Personal Injuries /c	85.4	91.9	224.8	106.3	260.5	35.8	84.4	295.4	146.6	131.9	132.4	101.0
Subtotal	154.8	159.0	332.9	160.3	317.3	103.7	192.4	374.5	238.9	245.5	311.8	221.0
General Aviation												
Aircraft Damage	131.4	122.3	130.3	154.2	137.9	123.3	134.8	139.6	138.7	123.2	136.8	144.1
Personal Injuries /c	829.0	821.0	895.5	1,075.3	945.1	870.9	888.2	943.8	922.9	931.4	894.1	860.1
Subtotal	960.4	943.3	1,025.8	1,229.5	1,083.0	994.2	1,023.0	1,083.4	1,061.6	1,054.6	1,030.9	1,004.2
Total	1,115.2	1,102.3	1,358.7	1,389.8	1,400.3	1,097.9	1,215.4	1,457.9	1,300.5	1,300.1	1,342.7	1,225.2
B. "AIRPORT ENVIRONMENT" ACCIDENTS												
Air Carrier												
Aircraft Damage	54.9	55.7	91.8	43.2	40.6	56.7	97.2	51.7	81.3	83.8	154.6	109.2
Personal Injuries /c	53.5	51.5	219.7	13.7	209.7	31.8	81.3	232.5	136.5	83.2	69.6	59.1
Subtotal	108.4	107.2	311.5	56.9	250.3	88.5	178.5	284.2	217.8	167.0	224.2	168.3
General Aviation												
Aircraft Damage	64.3	65.7	71.6	88.4	75.3	65.3	74.2	71.2	78.2	70.0	77.4	82.4
Personal Injuries /c	251.7	294.4	281.2	354.4	297.9	273.4	267.1	289.6	278.4	286.8	255.3	245.5
Subtotal	316.0	360.1	352.8	442.8	373.2	338.7	341.3	360.8	356.6	356.8	332.7	327.9
Total	424.4	467.3	664.3	499.7	623.5	427.2	519.8	645.0	574.4	523.8	556.9	496.2
C. "AIP-MITIGATED" ACCIDENTS d/												
Air Carrier												
Aircraft Damage	12.3	12.9	7.3	5.3	7.8	11.7	11.7	4.4	14.0	13.8	19.3	16.9
Personal Injuries /c	12.0	11.9	17.4	1.7	40.3	6.6	9.8	19.8	23.5	13.7	8.7	9.1
Subtotal	24.2	24.8	24.7	7.0	48.1	18.3	21.6	24.3	37.4	27.6	28.0	26.0
General Aviation												
Aircraft Damage	20.7	17.0	21.8	25.3	22.6	22.0	23.9	23.1	28.5	24.6	31.4	33.2
Personal Injuries /c	80.8	76.1	85.4	101.3	89.5	92.1	86.0	94.0	101.5	100.6	103.6	99.0
Subtotal	101.5	93.1	107.2	126.5	112.1	114.1	109.8	117.1	130.0	125.2	135.0	132.2
Total	125.7	118.0	131.9	133.6	160.2	132.4	131.4	141.4	167.5	152.8	163.0	158.2

a/ Details, as printed, may not add to totals due to independent rounding.
b/ See Table IV-1, footnote c, regarding classification changes over time.
c/ Personal injuries include those aboard aircraft of respective user groups and those on ground. They do not include those aboard other aircraft (in collisions) of other user group.
d/ Derived as described in text.

a. Accident costs associated with the "all accident" population were apportioned among the number of contributing causes and factors to account for the relative severity of individual causes and factors. In making the apportionment, the relative valuation of causes and factors were weighted in a ratio of 4 to 1, or:

$$\text{Cost of Each Cause} = \frac{4 \times \text{Total Accident Costs}}{(4 \times \text{Number of Causes}) + \text{Number of Factors}}$$

$$\text{Cost of Each Factor} = \frac{\text{Total Accident Costs}}{(4 \times \text{Number of Causes}) + \text{Number of Factors}}$$

That is, for example, in an accident involving citation of one cause and one factor, 80 percent of the accident cost was attributed to the cause and 20 percent attributed to the factor. This ratio formula was developed in two precedent studies (References 18 and 19) based on discussions with NTSB and FAA personnel. The average calculated costs per cause and factor are outlined in Table IV-6.

b. Applying the average costs per "AIP-mitigated" cause and factor citation outlined in Table IV-6 to the annual "AIP-mitigated" cause and factor citation frequency outlined in Table IV-4 yielded the annual "AIP-mitigated" accident costs outlined in Section C of Table IV-5.

TABLE IV-6

Average Apportioned Cost Per Cause and Factor Citation, CY 1970 - CY 1981

	Calendar Year a/											
	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
AIR CARRIER												
Total Accident Costs (Millions) b/	$154.8	$159.0	$332.9	$160.3	$317.3	$103.7	$192.4	$374.5	$238.9	$245.5	$311.8	$221.0
Number of Cause Citations c/	346	354	45	46	53	47	80	81	67	85	82	89
Number of Factor Citations c/	276	261	22	21	19	16	37	31	32	16	28	26
Avg. Apportioned Cost per Cause (Millions) d/	$0.373	$0.379	$6.592	$3.128	$5.494	$2.033	$2.156	$4.220	$3.185	$2.758	$3.503	$2.314
Avg. Apportioned Cost per Factor (Millions) d/	$0.093	$0.095	$1.648	$0.782	$1.374	$0.508	$0.539	$1.055	$0.796	$0.690	$0.876	$0.579
GENERAL AVIATION												
Total Accident Costs (Millions) b/	$960.4	$943.3	$1,025.8	$1,229.5	$1,083.0	$994.2	$1,023.0	$1,083.4	$1,061.6	$1,054.6	$1,030.9	$1,004.2
Number of Cause Citations c/	5,338	5,435	6,150	7,120	7,395	7,934	7,970	8,678	8,574	7,782	8,499	9,005
Number of Factor Citations c/	3,079	2,835	3,098	2,949	2,948	3,245	3,576	4,059	3,626	2,994	2,362	2,221
Avg. Apportioned Cost per Cause (Millions) d/	$0.157	$0.154	$0.148	$0.156	$0.133	$0.114	$0.115	$0.112	$0.112	$0.124	$0.113	$0.105
Avg. Apportioned Cost per Factor (Millions) d/	$0.039	$0.038	$0.037	$0.039	$0.033	$0.028	$0.029	$0.028	$0.028	$0.031	$0.028	$0.026
TOTAL												
Total Accident Costs (Millions) b/	$1,115.2	$1,102.3	$1,358.7	$1,389.8	$1,400.3	$1,097.9	$1,215.4	$1,457.9	$1,300.5	$1,300.1	$1,342.7	$1,225.2
Number of Cause Citations c/	5,684	5,789	6,195	7,166	7,448	7,981	8,050	8,759	8,641	7,867	8,581	9,094
Number of Factor Citations c/	3,355	3,096	3,120	2,970	2,967	3,261	3,613	4,090	3,658	3,010	2,390	2,247
Avg. Apportioned Cost per Cause (Millions) d/	$0.171	$0.168	$0.195	$0.176	$0.171	$0.125	$0.136	$0.149	$0.136	$0.151	$0.146	$0.127
Avg. Apportioned Cost per Factor (Millions) d/	$0.043	$0.042	$0.049	$0.044	$0.043	$0.031	$0.034	$0.037	$0.034	$0.038	$0.037	$0.032

a/ See Table IV-1, footnote c, regarding classification changes over time.
b/ From Table IV-5, Section A
c/ From Table IV-4, Section C
d/ Allocated as described in text.

E. BASIS FOR ASSESSING RATES OF "AIP-MITIGATED" ACCIDENTS AND COSTS

As a basis upon which to denominate and project the rates of "AIP-mitigated" accidents and their associated losses over time, this analysis uses aircraft operations as the unit of exposure. An operation occurs each time an aircraft either takes off or lands. Historic and forecast aircraft operations for the period FY 1970 through FY 2005 are presented in Appendix E. Operations are forecast through FY 2005 in order to encompass an assumed useful life of 20 years of the typical AIP investment from the base time frame (FY 1982 through FY 1985) in this report and the assumption of an average one-year lag between appropriation year and operational readiness of a typical AIP investment.

F. TIME SERIES ANALYSIS OF "AIP-MITIGATED" ACCIDENT COSTS PER AIRCRAFT OPERATION AND PROJECTION OF AIP SAFETY BENEFITS

1. Introduction

Based on the analysis of annual historic "AIP-mitigated" accident costs (from Section D) and annual aircraft activity (as described in Section E and outlined in Appendix E), this section postulates and quantifies two safety benefit scenarios. The reader's attention is invited to Tables IV-7 and IV-8 and Figures IV-1 and IV-2 to which the following discussion is directed.

2. Historic Time Series and Forecast Baseline

Columns B and C of Table IV-7 outline, for FY 1970 through FY 1986, the trend (in linear least squares form) of the annual estimated costs of "AIP-mitigated" accidents per aircraft operation, for air carrier and general aviation respectively, based on the accident data in Section D of this chapter and the schedule of historic and forecast aircraft operations detailed in Appendix E. The forecast accident cost trend constitutes the "baseline" against which each of the following scenarios was compared for estimation of AIP safety benefits. For purposes of projecting the "baseline" trend from the 1970-1981 historic study period to subsequent years, it is assumed that the relative contribution to safety from the AIP is approximately the same as that over the 1970-1981 historic study period during which federal aid was authorized under the Airport and Airway Development Program (ADAP) and Planning Grant Program (PGP). Although the accident costs were derived earlier in this chapter on a calendar year basis, it is additionally assumed that they are equivalent on a fiscal year basis.

3. Safety Benefit Scenarios

Two benefit scenarios are postulated and described below, each of which are compared to the "baseline":

a. Scenario I, Capital Stock Decay: The cost of "AIP-mitigated" accidents per aircraft operation is assumed to begin increasing as a result of the net decay in airport capital plant that would have resulted from a total absence of AIP grants from FY 1982 through FY 1985. For any year without AIP funding, the subsequent year's accident cost per aircraft operation is assumed to increase over that for the preceding year by a rate equal to the absolute value of the slope of the historic trend line. This increasing trend is assumed to occur beginning in FY 1983 and ending in FY 1986, reflecting an assumed one-year lag from appropriation year to operational readiness. Assuming a resumption of AIP funding in FY 1986, it is assumed that the accident cost differential would remain constant at the FY 1986 level from FY 1987 through the end of the phased life-cycle. For air carrier and general aviation respectively, this scenario is represented tabularly by Columns D and E of Table IV-7 and graphically in Figures IV-1A and IV-1B. The annual benefits per aircraft operation under this scenario are the differences between Columns D and B for air carrier and Columns E and C for general aviation in Table IV-7, or the vertical distances between the "capital stock" and "baseline" trend lines in Figures IV-1A and IV-1B.

b. Scenario II, Constant Cost: Beginning in FY 1983, the cost of "AIP-mitigated" accidents per aircraft operation is assumed to level out and remain constant at the FY 1982 rate from FY 1983 through FY 1986. Assuming a resumption of AIP funding in FY 1986, it is assumed that the accident cost differential would remain constant at the FY 1986 level from FY 1987 through the end of the phased life-cycle. For air carrier and general aviation respectively, this "constant cost" scenario is represented tabularly by Columns F and G of Table IV-7 and graphically in Figures IV-2A and IV-2B. The annual benefits per aircraft operation is the differences between Columns F and B for air carrier and Columns G and C for general aviation in Table IV-7, or the vertical distances between the "constant delta" and "baseline" trend lines in Figures IV-2A and IV-2B.

4. Safety Benefits Projection

Columns B and C of Table IV-8 summarize the annual historic and forecast traffic activity data detailed in Appendix E of this report. Columns D through G, for FY 1983 through FY 1986, represent the results of multiplying the "AIP-mitigated" accident cost differentials per aircraft operation for each benefit scenario from Table IV-7 by the annual aircraft operations activity in Columns B and C of Table IV-8. For FY 1987 and beyond, the differences in "AIP-mitigated" accident costs per operation are assumed to be equal to that estimated for FY 1986 under each scenario. These results, in billions of non-discounted 1982 constant dollars, are in turn multiplied by the respective 1985 present value factors in Column H to derive the unadjusted discounted benefits (in billions of 1982 constant dollars at their 1985 discounted present value) in Columns I through L. As can be seen from the footings in Table IV-8, the scenarios suggest total unadjusted life-cycle safety benefits ranging from $.46 to $.91 billion (1982 constant dollars at 1985 discounted present value) or a mean of $.69 billion ($.75 billion in 1985 dollars). This estimate should be viewed as a conservative, "least-case" amount.

TABLE IV-7

Time Series Analysis of "AIP-Mitigated" Accident Costs

(1982 Constant Dollars)

(A)	(B)	(C)	(D)	(E)	(F)	(G)
	Costs of "AIP-Mitigated" Accidents Per Operation					
			Scenario I		Scenario II	
	Baseline Trend		Capital Stock Decay		Constant Cost	
Fiscal Year	AC	GA	AC	GA	AC	GA
1970	2.893	1.488				
1971	2.847	1.421				
1972	2.800	1.354				
1973	2.754	1.287				
1974	2.707	1.219				
1975	2.661	1.152				
1976	2.614	1.085				
1977	2.568	1.017				
1978	2.521	0.950				
1979	2.475	0.883				
1980	2.428	0.816				
1981	2.382	0.748				
1982	2.335	0.681				
1983	2.288	0.614	2.382	0.748	2.335	0.681
1984	2.242	0.547	2.428	0.816	2.335	0.681
1985	2.195	0.479	2.475	0.883	2.335	0.681
1986	2.149	0.412	2.521	0.950	2.335	0.681
1987	Accident cost differentials projected for FY 1986 are assumed for purposes of analysis to remain constant over the remainder of the life-cycle (FY 1987 - FY 2005).					
1988						
1989						
1990						
1991						
1992						
1993						
1994						
1995						
1996						
1997						
1998						
1999						
2000						
2001						
2002						
2003						
2004						
2005						

FIGURE IV-1A

Scenario I: Capital Stock Decay (AC)

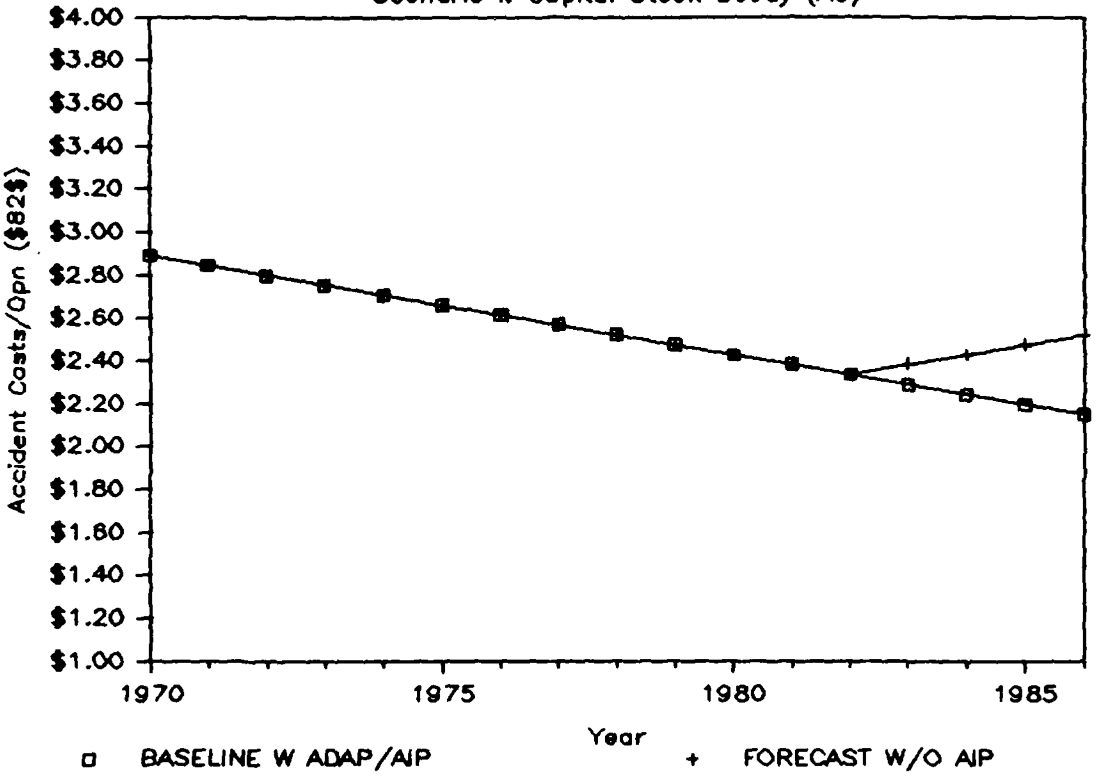

FIGURE IV-1B

Scenario II: Capital Stock Decay (GA)

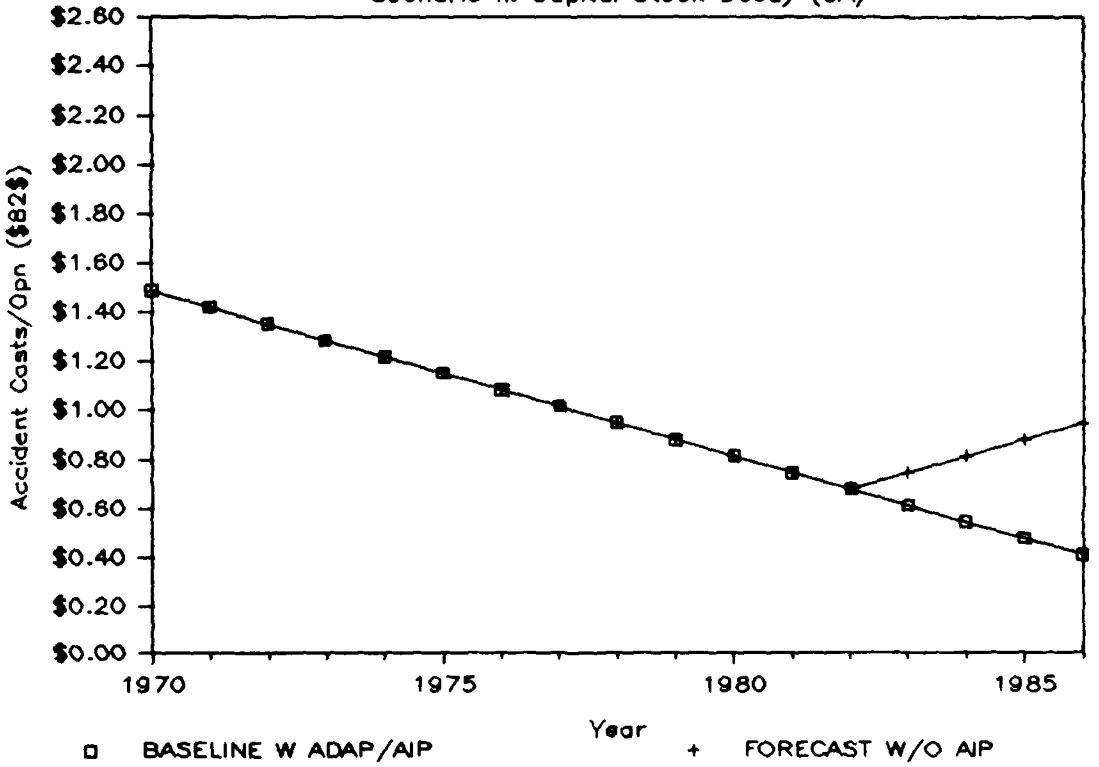

FIGURE IV-2A

Scenario II: Constant Cost (AC)

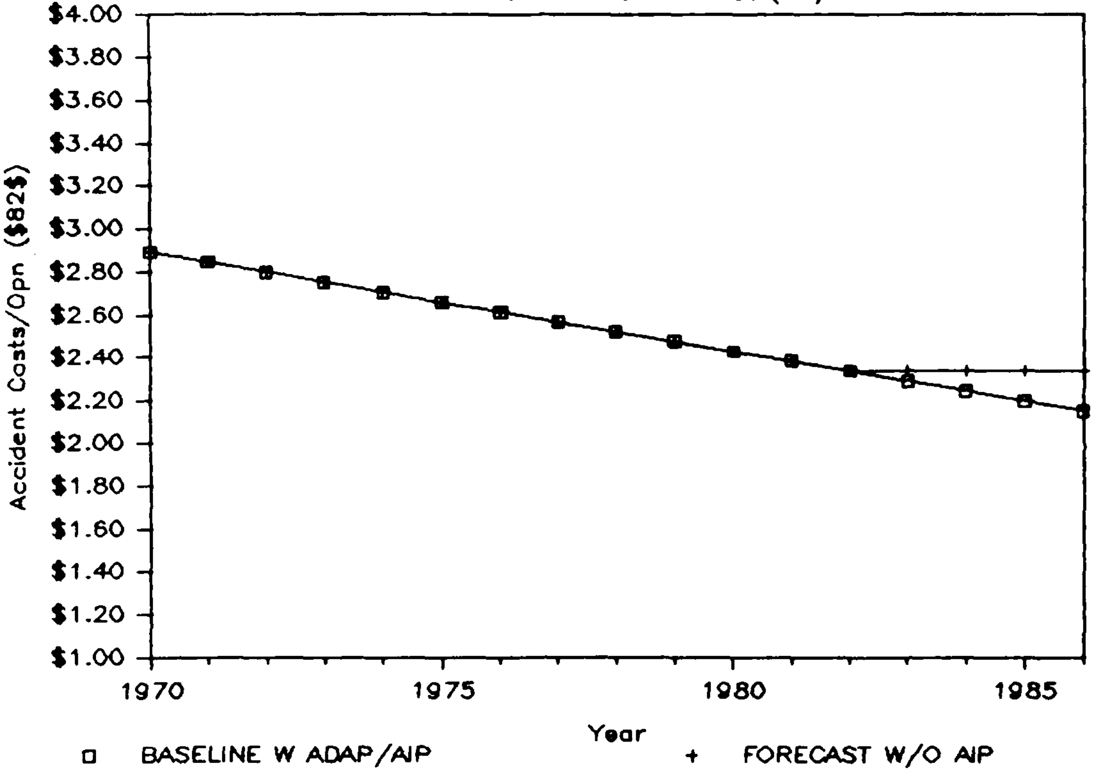

FIGURE IV-2B

Scenario II: Constant Cost (GA)

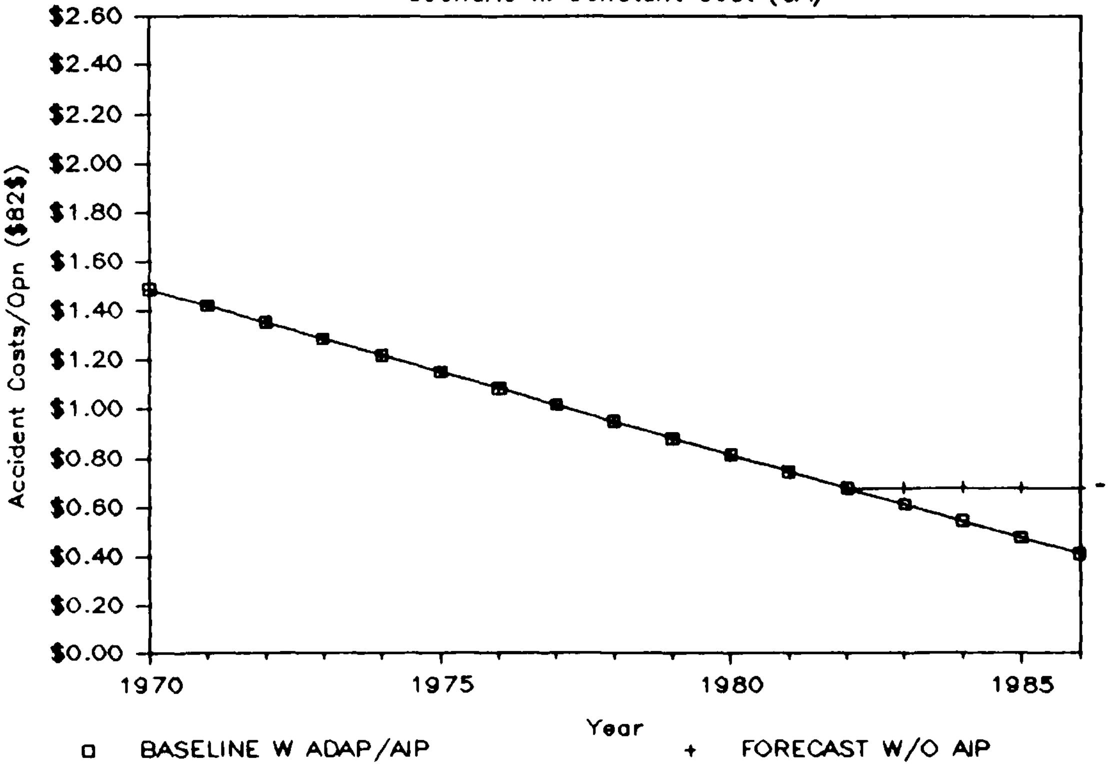

TABLE IV-8

Safety Benefits Projection (Unadjusted) a/

(A) Fiscal Year	(B) Total Aircraft Operations (Millions) AC	(C) Total Aircraft Operations (Millions) GA	(D) Non-Discounted, Unadjusted Benefits (Billions '82$) b/ Scenario I Capital Stock Decay AC	(E) Scenario I Capital Stock Decay GA	(F) Scenario II Constant Cost AC	(G) Scenario II Constant Cost GA	(H) 1985 Present Value Factor (@10%)	(I) Discounted (Present Value) Unadjusted Benefits (Billions '82$) Scenario I Capital Stock Decay AC	(J) Scenario I Capital Stock Decay GA	(K) Scenario II Constant Cost AC	(L) Scenario II Constant Cost GA
1970	10.8	95.8									
1971	10.1	92.1									
1972	9.7	91.7									
1973	9.8	91.6									
1974	9.5	97.1									
1975	9.4	100.6									
1976	9.9	107.5									
1977	10.3	112.4									
1978	10.6	119.6									
1979	11.0	124.5									
1980	10.7	128.3									
1981	10.1	126.5									
1982	9.6	118.5	0.0000	0.0000	0.0000	0.0000	1.331	0.0000	0.0000	0.0000	0.0000
1983	10.1	119.1	0.0009	0.0160	0.0005	0.0080	1.210	0.0011	0.0194	0.0006	0.0097
1984	11.1	124.1	0.0021	0.0334	0.0010	0.0167	1.100	0.0023	0.0367	0.0011	0.0184
1985	11.4	130.2	0.0032	0.0526	0.0016	0.0263	1.000	0.0032	0.0526	0.0016	0.0263
1986	11.6	135.0	0.0043	0.0727	0.0022	0.0363	0.909	0.0039	0.0660	0.0020	0.0330
1987	11.8	139.8	0.0044	0.0752	0.0022	0.0376	0.826	0.0036	0.0622	0.0018	0.0311
1988	12.1	144.7	0.0045	0.0779	0.0023	0.0389	0.751	0.0034	0.0585	0.0017	0.0293
1989	12.3	149.2	0.0046	0.0803	0.0023	0.0401	0.683	0.0031	0.0548	0.0016	0.0274
1990	12.5	153.6	0.0047	0.0827	0.0023	0.0413	0.621	0.0029	0.0513	0.0014	0.0257
1991	12.7	157.9	0.0047	0.0850	0.0024	0.0425	0.564	0.0027	0.0480	0.0013	0.0240
1992	12.9	162.5	0.0048	0.0875	0.0024	0.0437	0.513	0.0025	0.0449	0.0012	0.0224
1993	13.2	167.0	0.0049	0.0899	0.0025	0.0449	0.467	0.0023	0.0419	0.0011	0.0210
1994	13.4	171.7	0.0050	0.0924	0.0025	0.0462	0.424	0.0021	0.0392	0.0011	0.0196
1995	13.7	176.4	0.0051	0.0949	0.0026	0.0475	0.386	0.0020	0.0366	0.0010	0.0183
1996	13.9	181.2	0.0052	0.0975	0.0026	0.0488	0.350	0.0018	0.0342	0.0009	0.0171
1997	14.2	185.9	0.0053	0.1000	0.0026	0.0500	0.319	0.0017	0.0319	0.0008	0.0159
1998	14.5	190.5	0.0054	0.1025	0.0027	0.0513	0.290	0.0016	0.0297	0.0008	0.0148
1999	14.8	195.1	0.0055	0.1050	0.0028	0.0525	0.263	0.0015	0.0276	0.0007	0.0138
2000	15.1	199.7	0.0056	0.1075	0.0028	0.0537	0.239	0.0013	0.0257	0.0007	0.0129
2001	15.4	204.2	0.0057	0.1099	0.0029	0.0549	0.218	0.0012	0.0239	0.0006	0.0120
2002	15.7	208.7	0.0058	0.1123	0.0029	0.0562	0.198	0.0012	0.0222	0.0006	0.0111
2003	16.0	213.3	0.0060	0.1148	0.0030	0.0574	0.180	0.0011	0.0206	0.0005	0.0103
2004	16.3	217.9	0.0061	0.1173	0.0030	0.0586	0.164	0.0010	0.0192	0.0005	0.0096
2005	16.6	222.5	0.0062	0.1197	0.0031	0.0599	0.149	0.0009	0.0178	0.0005	0.0089
SUBTOTAL			0.1100	2.0269	0.0550	1.0135		0.0483	0.8650	0.0242	0.4325
TOTAL				2.1369		1.0684			0.9134		0.4567
MEAN (82$) ------------------->					1.6027					0.6850	
MEAN (85$) ------------------->					1.7541					0.7498	

a/ Unadjusted. See text for adjustment and explanation.

b/ Accident costs differentials in Table IV-7 multiplied by Columns B and C.

Because the various benefit quantification methodologies applied in this report have the potential for taking into account benefits generated by airport investments other than those associated with the AIP (e.g., the FAA's Facilities and Equipment Appropriation, non-AIP airport investments funded at state/local levels, etc.) an adjustment is warranted to net out the influence of these other investment sources. As with the other benefit chapters in this report, unadjusted benefits are carried forward to Chapter VII, Benefit/Cost Assessment, where the adjustment mechanism is derived and applied. It will be shown in Chapter VII that the unadjusted safety benefits fall from $.75 billion (1985 dollars at 1985 discounted present value) to $0.31 billion after being adjusted for the influences of safety-related airport investments funded by non-AIP sources. Of this adjusted total, the federal share is $0.14 billion.

CHAPTER V - CAPACITY AND ENVIRONMENTAL PROTECTION BENEFITS

A. INTRODUCTION

This chapter derives an estimate of the life-cycle capacity and environmental protection benefits that have accrued and that are projected to accrue from investments under AIP from FY 1982 through FY 1985 inclusively. Three types of AIP grants are examined: first, grants to promote the development of reliever airports; second, grants to attenuate noise pollution at airports; and third, grants for seal coating and resurfacing airport runways. While the focus of the analysis is on the AIP, the findings and conclusions can generally be postulated also for airside capacity and environmental protection investments from other airport funding sources as well, e.g., non-AIP state and local funding.

The primary purpose of reliever airports is to reduce air traffic congestion at major commercial service airports by drawing general aviation traffic away from the major airports. Under current law, 10 percent of AIP grants are allocated to developing reliever airports. Since FY 1971, the FAA has provided $573 million (in current year dollars) in grant funds for this purpose. Most of this amount, $367 million, was provided from FY 1982 through FY 1985.

AIP grants have been made since FY 1976 to help airports assess and attenuate aircraft noise pollution. Currently, eligible noise-related projects for AIP grants include noise compatibility plans, land acquisition, and airport development conducted in accordance with the Aviation Safety and Noise Abatement Act of 1979. From FY 1976 through FY 1984, $288.1 million was provided in grants to control airport noise pollution of which $133.8 million was provided from FY 1982 through FY 1984. Approximately, $85 million was provided as grants to airports for noise abatement in FY 1985.

Between FY 1982 and FY 1985, AIP grants for seal coating, repairing and resurfacing existing airport runways, taxiways and aprons totaled $367.7 million. Runways, taxiways, and aprons must be seal coated and resurfaced periodically; otherwise they begin to deteriorate. In fact, the pavement condition index[1/] for concrete pavements decreases 1.5% a year and 2.0% a year for asphalt pavements if they are not maintained properly. This deterioration in turn results in reduction of airport capacity. For example, if runways are not seal coated, small cracks and fissures develop and enlarge. Eventually, spaulding also occurs causing bits of concrete to break loose. This requires the runway to be temporarily closed more often so that it can be swept clean of debris. Another problem is that pot holes start to form. If they cannot be

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1 The pavement condition index is an index that measures the overall quality of the pavement (Reference 29, Table 3-8).

q[illegible] easily filled, the runway must be closed to fix them and restrictions may have to be placed on the type of aircraft that can use the runway. Temporarily closing runways, taxiways, and aprons to sweep them and restricting the type of aircraft that can use them reduces airport capacity. This reduction in capacity can be approximated by the reduction in the pavement condition index.

AIP grants help reduce or prevent increases of landing and takeoff delays at major commercial service airports. The dollar benefits resulting from reduced aircraft operating costs and passenger time saved are substantial. At the 31 major airports studied in this chapter, these benefits amount to $18.2 billion.[2] The total benefits of these investments between FY 1982 and FY 1985 total $21.9 billion when the benefits of the preventive maintenance program at general aviation airports are added to the estimated benefits for the 31 airports.

AIP grants are also provided to increase the capacity of existing airports and to increase the number airports available to serve U.S. aviation. From FY 1982 through FY 1985, the FAA provided $703.4 million (in current year dollars) in grant funds for this purpose. A major benefit of increasing capacity at major airports is reduction of delays. Most of the capacity changes at major airports are devoted to improving small components of the airport system (extending runways, improving approach aprons, etc.). These improvements are difficult to measure. The impact on delays from these types of airport improvements can best be estimated using individual simulation models for each airport. For example, temporarily closing two out of the 14 runways at O'Hare International Airport for construction purposes increases delays as much as 35 percent, assuming aircraft activity remains constant (Reference 28). This strongly suggests that adding two new runways at O'Hare would reduce delays by a comparable amount. Similar inferences can probably be made for the other major commercial airports. Unfortunately, this could not be done in this study because of time and resource limitations. Hence, the capacity benefits of the AIP included in the chapter are limited to those attributable to preserving existing capacity.

B. IMPACT OF AIP GRANT PROGRAMS

Capacity-oriented AIP grants generally affect airports in two ways. Some grant programs can change the number of aircraft operations occuring at an airport; other grants can help to maintain or to increase the airport's air traffic capacity. Changes in either the airport's capacity or air traffic activity can result in large changes in landing or takeoff delays.

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2 Due to data limitations, delays could be projected at only 29 major airports. These major airports are served by three carriers (Eastern Airlines, United Airlines, and American Airlines) which provide the FAA with detailed delay data.

As stated earlier, one major type of AIP grant is the development of reliever airports. The purpose of reliever airports is to draw general aviation activity away from major commercial services airports. An analysis of aircraft operations in the Terminal Area Forecast (TAF) Data System[3] suggests that reliever airports are drawing general aviation activity away from major commercial service airports. At 19 out of the 28 major airports studied (see Table V-1), general aviation activity is forecast to grow at a slower rate at the major airports than at their associated reliever airports. The lower growth rate of general aviation activity at the major airports is the result of the effectiveness of reliever airports at drawing away general aviation activity. If the reliever airports were not effective, general aviation activity at the major airports would be growing at the same or possibly higher rate as at the reliever airports. As a result, landing and takeoff delays are lower at major airports that have effective reliever airports.

AIP grants are used by airports to acquire land for noise buffer zones, to build noise barriers to deflect aircraft noise, and to study the impact of changing air traffic to reduce aircraft noise over the surrounding communities. A bilateral purpose of these efforts to reduce noise pollution is to prevent the surrounding local communities from forcing the airports to impose restrictions on airport operations. The type of restriction often considered is prohibiting aircraft from landing or taking off during night hours unless they are equipped with Stage III engines. For example, the airport authority at Boston is considering imposing this restriction at Boston Logan International Airport. Most commercial airlines are beginning to add aircraft with Stage III engines to their fleets, but currently 80 percent of the commercial airline fleet is not so powered. Thus, further propagation of curfew restrictions could, in effect, close these airports at night until commercial airlines refit their fleets.

This analysis assumes that airports with noise pollution problems will be closed between 10 p.m. and 6 a.m. unless other remedial measures can be implemented to protect the environment. The affected flights would have to be rescheduled or cancelled. These airport restrictions will bring about a reduction in airport capacity and a smaller reduction in the number of aircraft operations. The result is increased landing and takeoff delays (delays which the AIP environmental grants could reduce or prevent).

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[3] The Terminal Area Forecast Data System (Reference 26). The version used in this study has FY 1983 as the base year.

TABLE V-1

Average Annual Rate of Increase (Decrease) of General Aviation Operations between FY 1982 and FY 2005

City	LOCID	Hub	Reliever Airports
Atlanta	ATL	0.06%	3.2%
Boston	BOS	1.9%	4.2%
Baltimore	BWI	4.0%	4.6%
Cleveland	CLE	2.1%	1.7%
Cincinnati	CVS	3.8%	2.7%
Washington (National)	DCA	2.5%	4.1%
Denver	DEN	(3.4%)	3.4%
Dallas-Ft. Worth	DFW	0.5%	3.1%
Detroit	DTW	2.8%	4.3%
Newark	EWR	(5.8%)	2.9%
Houston	IAH	3.6%	2.4%
Indianapolis	IND	3.5%	2.1%
Jacksonville	JAX	1.8%	3.7%
New York (Kennedy)	JFK	0.2%	3.0%
Los Angeles	LAX	(3.0%)	3.4%
New York (LaGuardia)	LGA	(4.8%)	0.6%
Memphis	MEM	3.7%	2.6%
Miami	MIA	3.0%	2.5%
Minneapolis-St. Paul	MSP	4.0%	3.8%
New Orleans	MSY	3.9%	3.1%
Chicago	ORD	1.8%	4.2%
Philadelphia	PHL	0.3%	1.2%
Phoenix	PHX	0.7%	3.9%
Pittsburgh	PIT	3.3%	1.3%
Seattle-Tacoma	SEA	NA[1]	2.9%
San Francisco	SFO	(1.7%)	2.8%
St. Louis	STL	(4.3%)	1.9%
Tampa	TPA	1.2%	2.3%

1 Ground aviation activity eliminated by 2005.

If seal coating, repairing and resurfacing of pavements had been suspended for 4 years (FY 1982 through FY 1985), there would have been a 5.9% reduction in the condition index of concrete pavements and a 9.8% reduction in the condition index of asphalt pavements. In this analysis, it is assumed that in the absence of seal coating, repairing, and resurfacing projects, airport capacity is reduced by the same percentage amount as the reduction in the pavement condition index. Major airports are assumed to have concrete runways. Therefore, their capacities could be expected to decline by 5.9% if this work had not been performed for 4 years. General aviation airports and reliever airports are assumed to have asphalt runways, and their capacity could be expected to decline 9.8% over the four year period.

C. DELAY ESTIMATION

The impact of the AIP grant programs can be measured by comparing two different delay estimates for each airport in the study. First, delays at each airport are estimated assuming there were no AIP investments. Next, delays at each airport are again estimated assuming there were AIP investments. The difference in the delay estimates results from the AIP.

The following model[4] is used to estimate delays:

1) $$D_t = \frac{7*PF}{WF * (2.13 - [NAO_t/PANCAP]} - AC$$

where: D_t = annual average delay per aircraft operation (measured in minutes) in year t,

PF = the peaking factor (the number of air carrier operations scheduled during the 3 busiest hours of the day divided by the number of air carrier operations scheduled during other hours between 7 a.m. and 9:59 p.m.),

WF = a weather factor determined by the average amount of time at the airport when weather conditions are as good or better than 3 miles visibility and 1,500 feet cloud ceiling divided by the average amount of time these conditions are met at a sample of U.S. airports,

NAO_t = the projected number of aircraft operations at the airport during year t,

PANCAP = the practical annual capacity of the airport, and

AC = a constant calculated for airport.

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4 The original model was developed for the FAA (Reference 27) and was later modified by FAA-APO-120.

This model can be used without modification when delays are estimated for each airport assuming the existence of AIP investments. If the AIP had not existed, the values for NOA_t and PANCAP would have to be revised. In this model, the amount of time lost due to delay increases as NAO_t increases, and this delay time approaches infinity as NAO_t approaches 2.13 times PANCAP.

1. Revised Measurement for Capacity

Without AIP grants, airport capacity would be reduced due to the deterioration of runways, taxiways, and aprons and due to the restrictions imposed on night airport operations. To show this reduction in capacity, the values for PANCAP have to be revised.

Closing an airport between 10 p.m. and 6 a.m. reduces its PANCAP. As shown in equations 2 and 3, the revised PANCAP can be estimated by reducing the original PANCAP by the estimated number of aircraft operations affected by the above restrictions on airport operating hours.

2) $NAOA_{1983} = ACA * ACO_{1983} + ATCA * ATCO_{1983} + 0.043 * GAO_{1983} + 0.073 * MO_{1983}$

where:

$NAOA_{1983}$ = the number of aircraft operations at the airport affected by the night closure during FY 1983,

ACA = the fraction of air carrier operations at the airport affected by the restricted operating hours,

ACO_{1983} = the number of air carrier operations at the airport during FY 1983,

ATCA = the fraction of air taxi and commuter operations at the airport affected by the restricted operating hours,

$ATCO_{1983}$ = the number of air taxi and commuter operations at the airport during FY 1983,

GAO_{1983} = the number of general aviation operations at the airport during FY 1983, and

MO_{1983} = the number of military operations at the airport during FY 1983

If, for example, San Francisco International Airport (SFO) was closed between 10 p.m. and 6 a.m., 8.0 percent of air carrier departures (ACA) would be affected as well as 6.4 percent of commuter departures. This information can be obtained from the scheduled landings and departures for each airport. General aviation and military operations would also be affected, although the exact impact is unknown because specific information is not available for general aviation and military departures

at SFO. It can be estimated from national data that 4.3 percent of general aviation departures and 7.3 percent of the military departures will be affected by night closures (Reference 31). It is assumed in this analysis that the hourly percentage breakdown of aircraft arrivals is the same as that for aircraft departures.

Once $NAOA_{1983}$ is estimated, a partially revised PANCAP can be estimated using equation 3:

3) $$PRPANCAP = PANCAP - NAOA_{1983}$$

where:

PRPANCAP = the partially revised practical annual capacity of the airport,

PANCAP = the current practical annual capacity of the airport, and

$NAOA_{1983}$ = the revised number of aircraft operations at the airport affected by the restricted hours during FY 1983.

The partially revised PANCAP has to be further reduced to take into account the deterioration of runways, taxiways, and aprons that would occur if seal coating, resurfacing and other types of AIP-eligible repair work were not undertaken. At major airports, capacity would decrease 1.5 percent a year as runways, taxiways, and aprons deteriorated. If these types of AIP projects did not exist between FY 1982 and FY 1985 the deterioration would have continued for 4 years. At the end of 4 years, airport capacity would have declined by 5.9 percent to 94.1 percent of its former capacity. The required revision to the partially revised PANCAP to show this deterioration is:

4) $$RPANCAP = 0.941 * PRPANCAP$$

where:

RPANCAP = revised practical annual capacity of the airport, and

PRPANCAP = partially revised practical annual capacity of the airport (as calculated in equation 3).

Table V-2 shows the reduction of PANCAP at the 31 major airports used in this analysis.

2. Revised Measurement of Number of Aircraft Operations

The reduction in landing and takeoff delay times resulting from investments in reliever airports can be estimated for each major airport from two traffic projection scenarios--one which reflects investments in reliever airports and another which assumes that these investments were not made. The Terminal Area Forecast (TAF) Data System's projections of

aircraft operations, which implicitly reflect investments already made in reliever airports, are used to represent the existing situation of an ongoing program to develop reliever airports. Traffic projections for the alternative scenario where reliever airports do not exist must be calculated.

It is assumed that in the absence of investments in reliever airports, general aviation growth would be distributed proportionally across the major airport and its relievers. That is, general aviation traffic would grow at the same rate as at the major airport and its associated relievers. Diverted general aviation traffic would be equal to the difference between the major airport's general aviation traffic (projected at the general aviation growth rate at the major airport and its relievers) and the TAF forecast for general aviation traffic at the major airport, as indicated in equation 5.

5) $$GAD_t = (MRGR_t * MGA_{1982}) - MGA_t$$

where: GAD_t = the number of general aviation operations diverted to reliever airports in year t,

$MRGR_t$ = the projected growth rate of general aviation operations at the major airport and its relievers between FY 1982 and year t,

MGA_{1982} = the actual recorded number of general aviation operations at the major airport in FY 1982, and

MGA_t = the TAF forecast number of general aviation operations at the major airport in year t.

Note that if general aviation traffic is growing faster at the major airport than at the relievers, it is assumed that no relief is provided from investments in relievers. This is a conservative assumption, however, because reliever investments may have reduced major airport general aviation growth below what it otherwise would have been in the absence of these investments.

Projected general aviation traffic at the major airport, assuming no investment in reliever airports, can be calculated by adding the diverted general aviation operations to the TAF forecasts for each year as shown in equation (6).

6) $$RGAO_t = GAO_t + GAD_t$$

where: $RGAO_t$ = revised number of general aviation aircraft operations in year t without investments in reliever airports,

GAO_t = number of general aviation aircraft operations in year t as projected in the TAF, and

GAD_t = the estimated number of general aviation operations diverted from the major airport to its reliever airports.

TABLE V-2

Decreased Airport Capacity
(As Measured By PANCAP)

City	LOCID	PANCAP Original	PANCAP Revised
Atlanta	ATL	448,000	415,000
Boston	BOS	303,000	281,000
Baltimore	BWI	310,000	287,000
Charleston	CHS	195,000	177,000
Cleveland	CLE	295,000	274,000
Cincinnati	CVS	295,000	275,000
Washington (National)	DCA	275,000	253,000
Denver	DEN	355,000	327,000
Dallas-Ft. Worth	DFW	557,000	520,000
Detroit	DTW	475,000	443,000
Newark	EWR	280,000	260,000
Honolulu	HNL	525,000	487,000
Washington (Dullas)	IAD	390,000	362,000
Houston	IAH	300,000	277,000
Indianapolis	IND	195,000	179,000
Jacksonville	JAX	220,000	203,000
New York (Kennedy)	JFK	272,000	252,000
Los Angeles	LAX	448,000	415,000
New York (LaGuardia)	LGA	247,000	228,000
Memphis	MEM	335,000	309,000
Miami	MIA	395,000	367,000
Minneapolis-St. Paul	MSP	360,000	333,000
New Orleans	MSY	278,000	258,000
Chicago	ORD	616,000	572,000
Philadelphia	PHL	295,000	272,000
Phoenix	PHX	330,000	302,000
Pittsburgh	PIT	580,000	541,000
Seattle-Tacoma	SEA	280,000	261,000
San Francisco	SFO	400,000	372,000
St. Louis	STL	280,000	258,000
Tampa	TPA	355,000	329,000

For illustration, the amount of aviation activity diverted from San Francisco International Airport (SFO) to its reliever airports over time is shown in Table V-3. General aviation activity is projected to decline from 49,127 operations in FY 1982 to 42,109 operations in FY 2005. However, in the absence of reliever airport investments, SFO would handle more general aviation operations in the future than is currently projected to be the case. Without reliever airports, the number of general aviation operations at SFO would increase from 49,127 in FY 1982 to 86,749 in FY 2005.

In order to compute a revised NAO not only do the number of aircraft operations for general aviation have to be modified to show the impact of not having reliever airports, but the number of aircraft operations have to be modified again to take into account the effect that restrictions on airport night operations will have on general aviation and military aviation activity at these airports.

One of two things can happen to flights affected by night closures--they are either cancelled or they are rescheduled. It is doubtful that airlines would cancel any flights due to the major airports being closed during the night; this would be underutilizing aircraft. Rather, flights would probably be rescheduled. In this analysis, it is assumed that air carrier, commuter, and air taxi operators will reschedule their flights. With regards to general aviation, 59% of the affected flights (4.3% of all general aviation flights) would be cancelled or about 2.5% of all general aviation flights; 59% of the affected military flights (7.3% of all military flights) will also be cancelled or about 4.3% of all military flights (Reference 30).

The revised number of operations affected by the operating hour restrictions is given in equation 7 below:

$$7)\qquad RNAO_t = ACO_t + ATCO_t + 0.975 * RGAO_t + 0.957 * MO_t$$

where:

$RNAO_t$ = the revised number of aircraft operations at the airport during year t as forecast in the TAF,

ACO_t = the number of air carrier operations at the airport during year t as forecast in the TAF,

$ATCO_t$ = the number of air taxi and commuter operations at the airport during year t as forecast in the TAF,

$RGAO_t$ = the revised number of general aviation operations at the airport during year t as forecast in the TAF, and

MO_t = the number of military operations at the airport during the year t as forecast in the TAF.

TABLE V-3

Forecast Aircraft Operations
At San Francisco International Airport

Fiscal Year	TAF Operations With Reliever Airports	Estimated GA Operations Diverted To Reliever Airports	Estimated Operations Without Reliever Airports
1982	49,127	0	49,127
1983	50,139	2,123	52,262
1984	54,068	0	54,068
1985	54,281	1,182	55,463
1986	53,583	3,235	56,818
1987	52,894	5,461	58,355
1988	52,215	7,690	59,905
1989	51,545	9,897	61,442
1990	50,884	12,147	63,031
1991	50,232	14,400	64,632
1992	49,588	16,530	66,118
1993	48,953	18,673	67,626
1994	48,327	20,956	69,283
1995	47,700	23,329	71,029
1996	47,497	25,096	72,593
1997	46,873	27,265	74,137
1998	46,255	29,438	75,693
1999	45,644	31,622	77,266
2000	45,040	33,802	78,842
2001	44,442	35,978	80,420
2002	43,851	38,152	82,003
2003	43,264	40,319	83,583
2004	42,684	42,478	85,162
2005	42,109	44,641	86,750

The revised number of aircraft operations for SFO is shown in Table V-4.

3. Estimating Delays Resulting From Cancellation Of All AIP Capacity And Environmental Protection Projects At Major Airports

The delay model defined earlier in this section as equation 1 can now be used to estimate the average takeoff and landing delays if there were no AIP grants. This can be accomplished by substituting $RNAO_t$ for NAO_t and RPANCAP for PANCAP in the model formula.

Using San Francisco International Airport (SFO) as an example, aircraft operations would increase from 315,003 in FY 1982 to 448,367 in FY 2005 (see Table V-4) if AIP projects for it and its associated reliever airports were cancelled. Meanwhile, PANCAP would be reduced from 400,000 aircraft operations to 372,000 aircraft operations between FY 1983 and FY 1986. As a result of these two effects, takeoff and landing delays would increase from 5.05 minutes in FY 1982 to 7.89 minutes in FY 2005 (see Table V-5). However, if the AIP projects were maintained, aircraft operations would only increase to 404,895 by FY 2005 and delays would be 6.07 minutes by FY 2005. The time saved as a result of these AIP projects increases from 0.35 minutes in FY 1983 to 1.82 minutes in FY 2005.

D. ESTIMATING THE DOLLAR BENEFITS OF TIME SAVED

There are two types of savings that can be achieved by reducing airport delays. First, passenger time is "saved", and second, aircraft variable operating costs are reduced. For purposes of this analysis, the "critical" values outlined in Appendix A for air travelers' time and aircraft variable operating costs are adopted. A complete discussion of these and other critical values used in FAA's economic analyses and their underlying bases may be found in References 18 and 19.

The formula used to calculate the value of time saved each year at a given major airport is shown in equation 8.

$$8) \quad B_t = TS_t * [20.5 * (2 * TE_t + 3.2 * 0.975 * RGAO_t + 5.6 * 0.957 * MO_t) + 2404 * ACO_t + 245 * ATCO_t + 98 * 0.975 * RGAO_t + 851 * 0.957 * MO_t]/60$$

where:

B_t = the dollar benefits of time saved at the airport in year t,

TS_t = the time saved at the airport during year t as a result of the AIP projects,

TE_t = total air carrier, air taxi, and commuter aircraft operations at the airport during year t as forecast in the TAF,

ACO_t = the number of air carrier aircraft operations at the airport during year t as forecast in the TAF.

TABLE V-4

Effect of Restricted Airport Operating Hours
on Aircraft Operations
At San Francisco International Airport

Fiscal Year	Original Number of Aircraft Operations Without Reliever Airports	Number of Aircraft Operations Cancelled	Revised Number of Aircraft Operations
1982	315,003	0	315,003
1983	351,165	1,371	349,794
1984	393,424	1,490	391,934
1985	394,713	1,472	393,241
1986	396,887	1,455	395,432
1987	399,248	1,438	397,810
1988	401,626	1,421	400,205
1989	403,995	1,404	402,591
1990	406,421	1,388	405,033
1991	408,864	1,371	407,493
1992	411,196	1,355	409,841
1993	413,555	1,339	412,216
1994	416,067	1,323	414,744
1995	418,713	1,308	417,405
1996	424,346	1,303	423,043
1997	427,000	1,287	425,713
1998	429,690	1,272	428,418
1999	432,424	1,257	431,167
2000	435,188	1,241	433,947
2001	437,985	1,226	436,759
2002	440,818	1,212	439,606
2003	443,685	1,197	442,488
2004	446,586	1,182	445,404
2005	449,535	1,168	448,367

TABLE V-5

Current Projected Delay
At San Francisco International Airport

Fiscal Year	Estimated Aircraft Operations	Minutes Delay	TAF Aircraft Operations	(Minutes) Delay	Time (Minutes) Saved
1982	315,003	5.05	315,003	5.05	0.00
1983	349,794	5.74	349,042	5.39	0.35
1984	391,934	6.44	393,424	5.92	0.52
1985	393,241	6.58	393,531	5.92	0.66
1986	395,432	6.72	393,652	5.92	0.80
1987	397,810	6.76	393,787	5.92	0.84
1988	400,205	6.81	393,936	5.92	0.89
1989	402,591	6.86	394,098	5.93	0.93
1990	405,033	6.90	394,274	5.93	0.97
1991	407,493	6.95	394,464	5.93	1.02
1992	409,841	7.00	394,666	5.93	1.07
1993	412,216	7.05	394,882	5.94	1.11
1994	414,744	7.10	395,111	5.94	1.16
1995	417,405	7.16	395,384	5.94	1.22
1996	423,043	7.28	399,250	5.99	1.29
1997	425,713	7.34	399,735	6.00	1.34
1998	428,418	7.40	400,252	6.01	1.39
1999	431,167	7.47	400,802	6.01	1.46
2000	433,947	7.53	401,387	6.02	1.51
2001	436,759	7.60	402,008	6.03	1.57
2002	439,606	7.67	402,667	6.04	1.63
2003	442,488	7.74	403,366	6.05	1.69
2004	445,404	7.81	404,108	6.06	1.75
2005	448,367	7.87	404,895	6.05	1.82

$ATCO_t$ = the number of air taxi and commuter aircraft operations at the airport during year t as forecast in the TAF,

$RGAO_t$ = the revised number of general aviation aircraft operations at the airport during t as forecast in the TAF, and

MO_t = the number of military aircraft operations at the airport during t as forecast in the TAF.

As stated earlier, some general aviation and military flights will be cancelled due to restrictions on airport night operations. Thus only 97.5 percent of general aviation operations will take place, and only 95.7 percent of the military aviation operations will take place. The cancelled flights can also be valued and counted as a benefit because these flights would take place if AIP environmental grants were continued. However, the estimated benefits from not cancelling these flights are insignificant when compared to the benefits from reducing landing and takeoff delays.

Table V-6 shows the dollar benefits of the combined AIP projects at SFO. These benefits increase from $6.1 million in FY 1983 to $38.9 million in FY 2005. The sum of these annual benefits is $548.0 million. The present value of this stream of benefits indexed to 1985 is $241.7 million.[5]

The present value of the estimated benefits from the combined capacity and environmental protection AIP projects at the other 30 major airports were calculated using the same procedures as for SFO. The estimates for these airports are presented in Table V-7. The total present value of these benefits at all these airports is $18.2 billion. The overall total is probably a more accurate estimate of the benefits than the estimate for each airport. This is because individual airport estimates may contain positive or negative errors that are cancelled out by computing a total estimate of the benefits.

The total benefits of the three AIP grant programs have also been calculated separately. These benefits are:

- $3.1 billion from developing reliever airports
- $5.1 billion from seal coating, repairing, and resurfacing airport runways, taxiways, and aprons
- $4.3 billion from attenuating aircraft noise at airports

5 A 10 percent discount rate is used as prescribed by OMB.

TABLE V-6

Projected Annual Net Capacity and Environmental Protection Benefits at San Francisco International Airport

Fiscal Year	Time Saved	Estimated Annual Benefits (Thousand of 1982 Dollars)
1982	0.00	$ 0.0
1983	0.35	6,109
1984	0.52	9,963
1985	0.66	12,548
1986	0.80	15,279
1987	0.84	16,191
1988	0.89	17,128
1989	0.93	18,081
1990	0.97	19,076
1991	1.02	20,099
1992	1.07	21,100
1993	1.11	22,132
1994	1.16	23,251
1995	1.22	24,446
1996	1.29	26,164
1997	1.34	27,397
1998	1.39	28,673
1999	1.46	29,997
2000	1.51	31,364
2001	1.57	32,777
2002	1.63	34,239
2003	1.69	35,751
2004	1.75	37,316
2005	1.82	38,941
		$ 545,022

TABLE V-7

Estimated Present Value of Combined Capacity and Environmental Protection Benefits at Major Commercial Service Airports
(Millions)

Airport City	LOCID	Present Value of Benefits
Atlanta	ATL	$ 3,026.8
Denver	DEN	2,327.0
Los Angeles	LAX	2,318.7
Chicago	ORD	1,631.3
New York (Kennedy)	JFK	1,620.1
St. Louis	STL	1,121.7
Phoenix	PHX	1,063.1
Boston	BOS	885.4
Newark	EWR	735.0
Houston	IAH	576.1
Washington (National)	DCA	534.7
Philadelphia	PHL	409.0
New York (LaGuardia)	LGA	376.5
San Francisco	SFO	241.7
Minneapolis-St. Paul	MSP	212.9
Baltimore	BWI	201.3
Seattle-Tacoma	SEA	192.2
Dallas-Ft. Worth	DFW	115.4
Miami	MIA	104.6
Memphis	MEM	83.8
Honolulu	HNL	66.2
Detroit	DTW	65.7
Tampa	TPA	58.0
Cleveland	CLE	53.0
Indianapolis	IND	43.7
Pittsburgh	PIT	35.8
New Orleans	MSY	26.8
Washington (Dullas)	IAD	22.1
Jacksonville	JAX	17.5
Cincinnati	CVG	12.2
Charleston	CHS	8.3
Total		$ 18,186.6

The total of these benefits is $12.5 billion which is $5.7 billion less than the total benefits from the combined programs. There is an interaction effect among these AIP grant programs which creates the extra $5.7 billion. This interaction effect is lost when benefits are calculated separately for each type of AIP grant program.

E. BENEFITS OF MAINTAINING GENERAL AVIATION AIRPORTS

General aviation airports are generally too small to serve large jets and usually are not located near enough to large residential areas for noise pollution to be a problem. The major benefit of AIP grants to general aviation airports is the protection and repair of runways, taxiways, and aprons.

Cutting back on work to protect, repair and resurface runways, taxiways and aprons for 4 years at reliever and general aviation airports would reduce their capacity by 9.8%. Since most of these airports have low levels of activity, a reduction in airport capacity would have no noticeable effect on takeoff and landing delays. The most noticeable impact would be on the amount of time the airport would remain open. If the runway is allowed to deteriorate, cracks develop and widen, spaulding occurs, and pot holes develop. If spaulding gets too severe the runway would have to be closed temporarily so that it could be swept. If cracks widen too much or pot holes develop the runway would also have to be temporarily closed so that the cracks and pot holes could be patched. The greater the deterioration of the runway, the more often it would have to be temporarily closed to correct these problems. Some runways may even have to be closed permanently. As a result of these temporary closures, more general aviation flights would be cancelled, delayed, or diverted than would be the case if the runways, taxiways, and aprons had been properly protected and repaired.

The average cost of a general aviation flight that is cancelled, diverted, or delayed is $146.52 (see Table V-8). The benefits of protecting and repairing runways, etc. at general aviation and reliever airports from FY 1982 through FY 1985 can be computed using equation 9 below:

$$VM_t = NGAT_t * 0.098 * 146.52 \qquad (9)$$

where:

VM_t = the value of flights made possible in year t by grant projects to protect, repair, and resurface runways, taxiways, and aprons, and

$NGAT_t$ = the number of general aviation operations made in year t as forecast in the TAF.

The cumulative annual benefits for these types of projects at general aviation and reliever airports comes to $7.2 billion by FY 2005 (see Table V-9). Once the dollar value has been computed for each year, the present value is computed using a 10 percent discount rate, and then indexed to 1985. In this case, the present value is $3.[illegible] billion dollars

TABLE V-8

General Aviation Flight Disruption Costs

Type of Disruption	Cost Equation	Relative Weight
Delay	$0.5 * V_{pt} * n + 0.3 * AOC$	0.38
Cancellation	$2.5\ V_{pt} * n$	0.55
Diversion	$(2.0\ V_{pt} + V_{dvg}) * n + 1.5 * AOC$	0.07

where:

V_{pt} = Hourly value of passenger time--$20.50 in 1982 dollars,

n = Number of deplaning passengers (3.2),

V_{dvg} = Passenger handling expense for diverted passengers--$57.00 in 1982 dollars (includes overnight lodging expense and transportation cost to original destination), and

AOC = Aircraft variable operating cost per airborne hour--$98 in 1982 dollars.

Weighted average:

$$(1.71\ V_{pt} + 0.07\ V_{dvg}) * n + 0.22 * AOC$$

$$(1.71 * 20.5 + 0.07 * 57) * 3.2 + 0.22 * 98 = \$146.52$$

Source: Reference 30.

F. SUMMARY

The United States receives substantial capacity and environmental protection benefits from the AIP. The benefits at only 31 major airports from AIP grants devoted to improving airport capacity and environmental protection is approximately $18.2 billion. The benefits from protecting, repairing, and resurfacing runways, taxiways, and aprons at general aviation airports total another $3.7 billion. All totalled, there are $21.9 billion in benefits from the types of AIP grants studied in this chapter.

TABLE V-9

Annual Benefits of General Aviation Operations Made Possible by Maintaining General Aviation And Reliever Airports

Fiscal Year	Benefits (in millions of 1982 dollars)
1982	$ 0.0
1983	60.7
1984	124.3
1985	191.0
1986	260.3
1987	268.7
1988	277.3
1989	286.5
1990	296.4
1991	305.9
1992	315.6
1993	324.7
1994	334.3
1995	344.5
1996	348.7
1997	359.4
1998	369.8
1999	373.8
2000	384.9
2001	378.8
2002	382.0
2003	393.8
2004	386.5
2005	389.1
	$7,157.0

CHAPTER VI - ECONOMIC DEVELOPMENT BENEFITS

A. INTRODUCTION

Beyond the "direct" benefits of the AIP addressed in earlier chapters of this report, there are other benefits of a more general or indirect nature. Civil aviation is a major component of the national economy and has a major impact on our life styles. Many benefits from civil aviation, which we now take for granted, would not be possible without the modern airport system funded in part by the AIP. This chapter will address the benefits of civil aviation, the impact of airports on local economies, and the impact of the AIP investments on the national economy.

B. IMPACT ON CIVIL AVIATION

Civil aviation has a major impact on the U.S. economy. In 1984, scheduled passenger and cargo traffic generated $44 billion from carriage of 343 million passengers and 8.1 billion ton-miles of freight and mail. During this time U.S. air carriers also employed 345,000 people (Reference 37). General aviation makes a major contribution to the economy by carrying one in three intercity passengers and by providing an air link to over 19,000 communities that do not receive regular scheduled airline service. Moreover, in 1982 there were over 200,000 civil aircraft and civil aircraft sales exceeded $11 billion (Reference 33).

Civil aviation also contributes to the economy in other ways as well. Air travel promotes efficiency of business activity. By providing low cost rapid travel, it lowers costs of control and operation. This permits business to seek out optimal production locations based on factors such as access to natural resources, proximity to markets, presence of skilled labor, etc., rather than being tied to centers where their corporate or regional headquarters are located. The ultimate result is lower production costs. It also allows lower inventories of critical high value to weight materials to be maintained with attendant cost savings. Should a critical component or part be unexpectedly needed, it can be cheaply and quickly flown in with only minimal disruption to business operations. Because of these and similar factors, businesses are more likely to establish new plants and factories in communities not so served. As a consequence, the large number of airports scattered throughout the country has had substantial impact on the nation's economic growth.

The combination of speed and economy of air travel has altered the way people travel and spend their vacations. Before 1950, only the wealthy could travel to such places like Florida, Hawaii, Europe, or the Caribbean. Now, because of inexpensive air travel, many more can travel to these places, and the tourist industries there have developed and grown as a result. The increase in personal mobility brought about by air travel has also resulted in the tremendous growth in travel-related industries such as car rental, travel agency, food service, and hotels.

Civil aviation has also had an impact on agriculture. For example, crop spraying to control insects is often done by air. The availability of many fresh fruits and flowers in local markets is made possible only because air transportation can quickly get these highly perishable products from grower to market. Air transportation has also made possible the development of a new industry devoted to the overnight delivery of packages and mail. When time is of the essence for the delivery of medical supplies or legal documents, for example, the air delivery business meets this need.

These are but a few examples of how aviation has not impacted the economy and improved our lives. But these developments would not be possible, if the U.S. had not developed the necessary airports, supported by substantial Federal airport grants-in-aid, to handle the large amount of air traffic that now exists.

C. IMPACT OF AIRPORTS ON LOCAL ECONOMIES

Not only are airports an essential part of the national aviation system, but airports have a major impact upon local economies. The major airports in the New York metropolitan region, for instance, added $18.9 billion to the local economy in 1984. In the same year an estimated 293,000 jobs were generated there. The three major airports (Kennedy, Newark, and LaGuardia) employed 67,400 people; another 143,800 jobs were provided in aviation and related industries away from these airports; and 149,200 jobs were created in other industries in the metropolitan area. Most of this economic impact was generated by Kennedy; 207,800 jobs and $13.6 billion were attributed to that airport alone (Reference 32).

A similar economic impact is observed at other airports. Phoenix International Airport had a $7.5 billion impact in the Phoenix area in 1983, while the Tucson Airport had a $1.4 billion impact on the Tucson economy. In 1980, Bradley International Airport employed 2,269 people and contributed $219 million (directly or indirectly) to the Hartford - Springfield area (Reference 34). Albuquerque International Airport was the eighth largest employer in its region, with 1,605 employees and a $183 million annual total economic impact. Allentown-Bethlehem-Easton Airport had 752 employees and contributed $50 million annually to the economy of the Lehigh Valley. When aircraft manufacturing takes place on an airport, the impact increases. Burbank-Glendale-Pasadena Airport accounted for 22,000 jobs which generate $557 million in annual earnings (Reference 1).

Economic impact is not limited to commercial service airports. A report for the Florida Department of Transportation in January 1983 indicated that general aviation accounts for almost 10,000 jobs and over $600 million in total impacts annually in that state. The average total economic impact per general aviation aircraft was $93,000 annually. An overview of the aviation industry in Arizona revealed a total economic impact of $7.4 billion and 146 thousand jobs (Reference 1).

D. IMPACT OF THE AIP ON THE NATIONAL ECONOMY

The AIP not only makes air travel safer and more convenient for the general public, but also has an expansionary impact on the national and

local economies. AIP investments create jobs directly as construction is performed, and indirectly in related industries. Approximately 26,700 jobs were created directly each year by AIP projects between FY 1982 and FY 1985; another 10,000 jobs were created each year to support airport construction work.[1]

The aggregate impact on the economy arising from AIP expenditures can be quantified by estimating the increase in Gross National Product (GNP) resulting from these expenditures. This impact will be larger than the amount of the initial expenditure. An increase in GNP equal to the AIP expenditures will occur as the funds are initially spent. In addition, GNP will be generated as these monies are again spent and re-spent. The total impact of the original expenditure can be calculated using an appropriate multiplier and the value of the original AIP expenditures. A study by the Bureau of Economic Analysis (Reference 35) suggests a multiplier of 2.5 for this type of expenditure. Applying this multiplier to $3.2 billion, the 1985 present value of basic AIP expenditures from FY 1982 through FY 1985 from Table II-3, yields an estimate of the economic impact of the AIP of $8.0 billion.

Besides the impacts noted above, Federal AIP expenditures have also stimulated state and local investments in airports. This has come about in two ways. First, the AIP requires that federal funds be matched, to some extent, by state and local funds. Second, AIP grant agreements require state and local sponsors to fund related operations and maintenance costs. The impact of state and local spending is akin to federal spending. Economic growth is stimulated, new industries made possible, local economics impacted and additional GNP generated. The impact on GNP of state and local AIP related expenditures may be quantified, as above with Federal expeditures, by applying the multiplier (2.5) to the present value of the expenditures ($3.8 billion from Table II-3). This yields an impact of $9.6 billion.

In addition, because only certain projects are eligible for AIP funding a need arises for investment in complementary projects which are not covered by the AIP and which must be undertaken with non-AIP state and local funds. For example, AIP eligible projects are primarily airside in nature. As these are built, it is necessary to undertake associated landside projects.

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1 The number of jobs created was derived from data in Reference 36, Table 2.6.

E. SUMMARY

Airport grant programs have been a major contributor to the development of civil aviation since 1950. As a result of the development of civil aviation made possible by the nation's large number of airports, our lives have been improved in ways that would not have been possible without aviation. Airports built with the aid of Federal funds have become major contributors to local economies and in some cases major employers. In addition, these investments have fostered general economic growth and development by lowering costs of production and control, and by making possible whole new industries. Federal grant funds provided to help build airports and required state and local matching funds and operations and maintenance expenditures have also resulted in an increase in the GNP of approximately $17.6 billion. Moreover, federal grants have also helped stimulate state and local airport investments in complementary airside and landside facilities. This spending has had the impact of generating additional economic growth and development as well as additional GNP.

CHAPTER VII - SUMMARY BENEFIT/COST ASSESSMENT

A. INTRODUCTION

This chapter consolidates the results of the individual benefit and cost chapters presented earlier in this report, providing a basis upon which to estimate the life-cycle benefit/cost ratios which can be postulated for major airside AIP investments made from FY 1982 through FY 1985. While the center of focus in this report has been the AIP, the findings and conclusions are applicable to the other airport funding sources as well, e.g., non-AIP state and local funds. The render is again alerted to the fact that because not all types of benefits are quantified, the study should be considered conservative in that it probably understates total investment impact.

As indicated earlier, the various benefit quantification methodologies applied in this study have the potential for taking into account benefits generated by airport investments other than those associated with the AIP, e.g., the FAA's Facilities and Equipment Appropriation, non-AIP airport investments funded at state/local levels, etc. This chapter derives an adjustment proxy by which the influence of these other funding sources are netted out of the unadjusted benefit findings.

The reader's attention is invited to Table VII-1 and Figure VII-1 to which the following discussion is directed.

B. CONSOLIDATION OF BENEFIT AND COST FINDINGS

Sections A and B of Table VII-1 respectively summarize the quantified life-cycle benefit and cost findings. Column A presents summary totals on an unadjusted basis, i.e., before netting out that portion of the benefits which may be allocable to non-AIP funding sources and before adjusting the costs for alignment with the benefits quantified. Column B outlines the adjustment factors, explanations for which are presented in the following section of this chapter. Column C reflects the adjusted totals, i.e., the adjusted benefits allocable to the AIP itself (including both federal and state/local shares) and the costs allocable to these benefits. Columns D and E then apportion the adjusted totals between the federal and state/local levels..

C. DERIVATION OF ADJUSTMENT FACTORS

1. Adjustment Factor for Benefits

The methodology used for adjusting or allocating the benefits quantified in this report to AIP sources is based on relative investment. Figure VII-1 outlines a schematic of the breakdown of total capital/planning investment in U.S. public airports from FY 1982 through FY 1985. Since the safety, capacity and environmental protection benefits quantified in this report are airside only, the portion allocated to AIP funding sources can be estimated by:

$$\frac{\text{AIP-Funded Airport Airside Investments}}{\text{Total Airport Airside Investments}}$$

$$= \frac{\text{AIP-Funded Airport Airside Investments}}{\text{AIP-Funded Airport Airside Investments} + \text{All Other Airport Airside Investments}}$$

Substituting 1985 discounted present values from Figure VII-1 yields:

$$\frac{\$3.66 \text{ billion}}{\$3.66 \text{ billion} + \$5.07 \text{ billion}}$$

$$= \frac{\$3.66 \text{ billion}}{\$8.73 \text{ billion}}$$

$$= 41.9\%$$

In other words, it is assumed that of the unadjusted safety, capacity and environmental protection benefits, 41.9% is allocable to AIP funding sources and 58.1% to all other funding sources. In the case of economic development benefits, the adjustment factor of 0.895 reflects that portion of total AIP investments which are airside in nature.

2. Adjustment Factors for Costs

In the case of costs, two adjustments are warranted. First, STAA investments must be netted out in their totality since their corresponding benefits are not captured in the benefit estimates. Secondly, since the benefits quantified are airside only, landside investments must be netted out. For the period FY 1982 through FY 1985, the breakdown of total AIP investments was approximately 89.5% airside and 10.5 percent landside. Therefore, the adjustment factors become 0.0 percent for STAA investments and 89.5% for other costs associated with AIP investments.

D. BENEFIT/COST RATIO SUMMARY

As illustrated in Section C of Table VII-1, consolidation of the adjusted benefits and costs in Columns C through E yields a benefit/cost ratio of 4.00 to 1. Because benefits are allocated to the federal and state/local levels based on relative costs, the benefit/cost ratios for the AIP as a whole and for the federal and state/local shares are by definition equivalent.

TABLE VII-1

Summary Benefit/Cost Assessment a/

(Dollar Amounts in Billions of 1985 Dollars at 1985 Discounted Present Value)

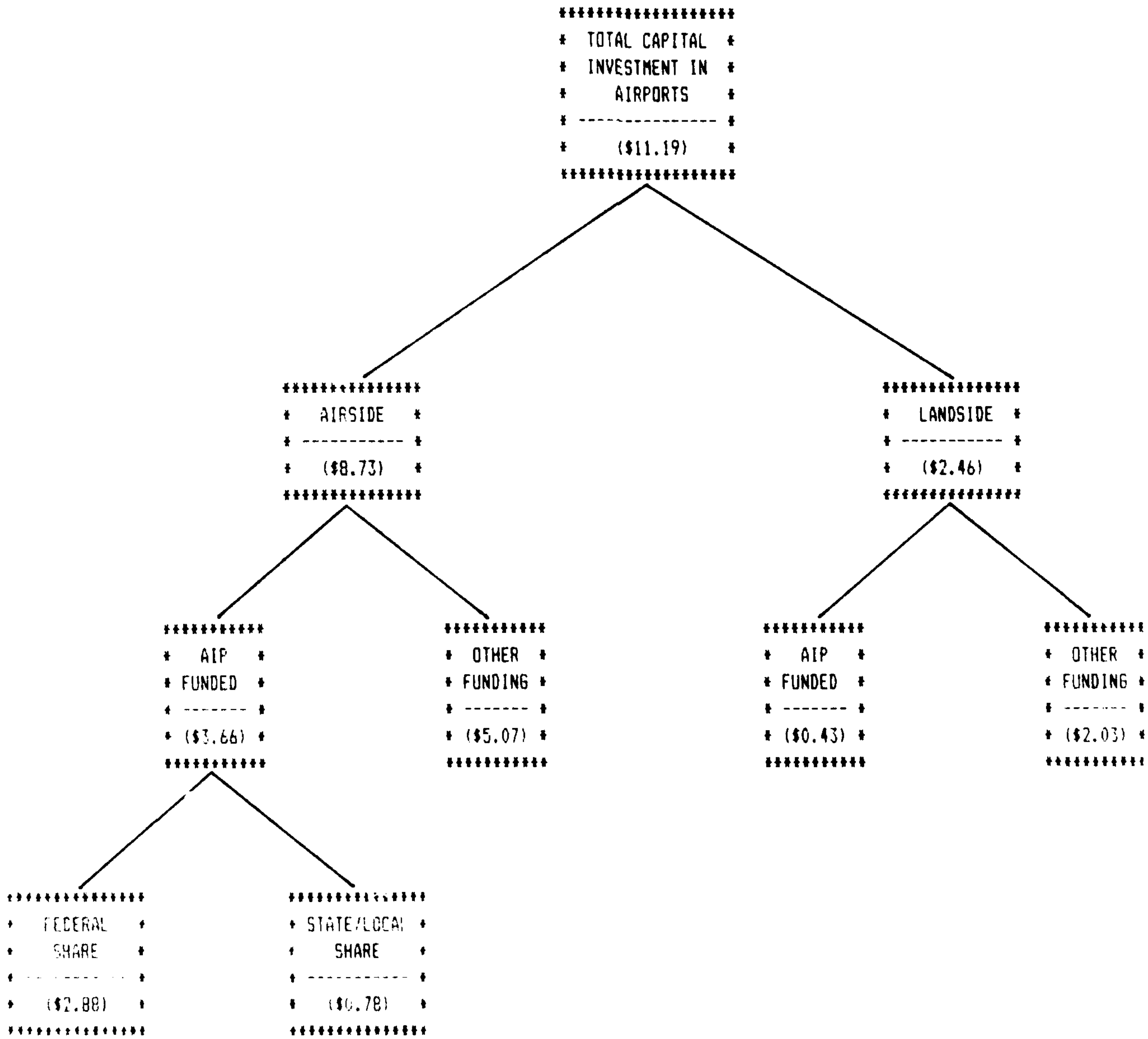
Category	(A) TOTAL (FEDERAL+STATE/LOCAL) UNADJUSTED TOTAL	x	(B) ADJUSTMENT FACTOR b/	=	(C) ADJUSTED TOTAL		(D) ALLOCATED SHARES c/ FEDERAL	(E) STATE/ LOCAL
A. QUANTIFIED LIFE-CYCLE BENEFITS (Chaps IV - VI)								
Safety (Chapter IV)	0.7498	x	0.419	=	0.3142	>>	0.1433	0.1709
Capacity and Environment (Chapter V)	21.8866	x	0.419	=	9.1705	>>	4.1817	4.9887
Economic Development (Chapter VI)	17.6468	x	0.895	=	15.7939	>>	7.2020	8.5919
TOTAL QUANTIFIED BENEFITS	40.2832				25.2785	>>	11.5270	13.7515
B. LIFE-CYCLE COSTS (Chapter II)								
INVESTMENT (FY 1982 - FY 1985)								
Federal								
Basic AIP (Capital+Planning)	3.2197	x	0.895	=	2.8816	>>	2.8816	0.0000
STAA	0.5536	x	0.000	=	0.0000	>>	0.0000	0.0000
Total	3.7733				2.8816	>>	2.8816	0.0000
State/Local	0.8716	x	0.895	=	0.7801	>>	0.0000	0.7801
Total	4.6449				3.6617	>>	2.8816	0.7801
RECURRING OPNS & MAINT (FY 1983 - FY 2005)	2.9673	x	0.895	=	2.6557	>>	0.0000	2.6557
TOTAL	7.6123				6.3174	>>	2.8816	3.4358
C. LIFE-CYCLE BENEFIT COST SUMMARY								
Benefits (from Section A) ....>					25.2785		11.5270	13.7515
Costs (from Section B) ....>					6.3174		2.8816	3.4358
Benefit/Cost Ratio ....>					4.00		4.00	4.00

a/ Some printed totals may not reconcile due to rounding.
b/ See text for explanation.
c/ Benefits are allocated between federal and state/local levels based on relative life-cycle costs (45.6% federal; 54.4% state/local).

FIGURE VII-2

Allocation of Airport Investments, FY 1982 - FY 1985

(Dollar Amounts in Billions of 1985$ at 1985 Present Value)



* Source: FAA APO 220, based on data from References 1,3,11,38, Table II-3 of this report, and FAA Office of Airport Planning and Programming.

APPENDIX A

Critical Values

A. INTRODUCTION

The FAA uses certain economic values, commonly referred to as "critical values," in its evaluation of investment and regulatory programs. This appendix briefly describes the critical values used in this report. A more detailed discussion of these and other critical values used in FAA's economic analyses and their underlying bases may be found in "Economic Values for Evaluation of FAA Investment and Regulatory Programs" (Reference 21) and a supplemental update of the same title (Reference 22).

B. SAFETY

1. Value of a Statistical Life: Several theoretical and empirical approaches have been developed in government, academic and other circles to the estimation and valuation of human life. Methods considered in the above referenced study include the human capital approach (present value of a typical air traveler's expected future earnings stream), court awards (or judicial settlements) approach, willingness-to-pay approach (premiums individuals would be willing to pay/accept to reduce/increase their risk of death by some small finite amount), and the value to self and others approach (passenger's willingness-to-pay plus the value of the passengers' lives to family, community, employer, Government and airlines). The approach recommended in the above referenced study for FAA use, a combined and modified version of the willingness-to-pay (revealed preference) and value to self and others approaches, is applied in this report -- $620,000 per statistical life (in 1982 dollars). It constitutes a compromise between the values suggested by the various approaches cited.

2. Costs of Nonfatal Injuries: As with the value of a statistical life, the above referenced study outlines several alternative but similar approaches to placing unit costs on statistical aviation-related nonfatal injuries. The approach recommended by the referenced study for FAA use and applied in this report is the value to self and others approach -- $45,000 for a serious injury and $17,000 for a minor injury (in 1982 dollars).

3. Unit Costs of Aircraft Damage: The NTSB categorizes aircraft damage as destroyed, substantial, minor and none. The loss of an aircraft completely destroyed in an accident can be approximated by the market value of its replacement. Market values generally represent the discounted present value of the future stream of earnings (for revenue producing operations) or satisfactions (for non-revenue producing operations) which may be derived from an aircraft. "Replacement cost," as used here, is that weighted cost of replacing a destroyed aircraft with similar aircraft from the used aircraft market. Because actual market valuations are utilized, depreciation and obsolescence are implicitly taken into account. Insurance experience reveals that the average

restoration cost of a substantially damaged aircraft is approximately one-third of its market or replacement cost. Repair costs of aircraft incurring minor damage are relatively negligible within the context of the safety benefits in this report and therefore are extended no cost or loss allowance. The unit costs of aircraft damage used in this report are outlined below in thousands of 1982 dollars:

Air Carrier	Destroyed	Substantial Damage
Large Fixed-Wing		
Part 121	$8,100	$2,700
Part 135	1,058	353
Small Fixed-Wing		
Part 121	390	130
Part 135	44	15
Rotor		
Part 121	171	57
Part 135	171	57
General Aviation		
Large Fixed-Wing		
Including taxi/commuter	1,237	412
Excluding taxi/commuter	1,271	424
Small Fixed-Wing		
Including taxi/commuter	45	15
Excluding taxi/commuter	44	14
Rotor		
Including taxi/commuter	126	42
Excluding taxi/commuter	112	37

C. CAPACITY

1. Value of Air Travelers' Time: Much like the valuation of a statistical life, several theoretical and empirical approaches have been developed for the value of time spent in travel. Methods considered in the above referenced study include the labor product approach and the willingness-to-pay approach. The range of opinion on the value of time in air travel varies between some fraction of the earnings rate and three times the earnings rate. Obviously, this range makes the adoption of a value of time for FAA investment and regulatory decisionmaking purposes a rather tentative one. The value recommended for FAA use by the referenced study, the average hourly earnings rate of the "typical" air traveler, is used in the report ($20.50 per hour in 1982 dollars).

2. Aircraft Variable Operating Costs: The above referenced study provides aircraft "variable" operating costs by user class and aircraft type. As used in the context of this report, aircraft variable operating costs include paid flight crew, fuel, oil, and direct maintenance of airframe, avionics and engine. Costs of a semi-variable or fixed nature are excluded because they do not vary materially or do not vary at all with small changes in aircraft operating time. Flight crew salaries and wages are included only for air carrier, air taxi, and air commuter operations in this report. Crews for all other operations are included in occupant load factors and accordingly are extended the average value of air passengers' time as a proxy for the value of their time.

APPENDIX B-1

"AIP-Mitigated" Cause/Factor Citation Frequency, All Operations, CY1970 - CY1981 a/

Cause/Factor Citation	1981		1980		1979		1978		1977		1976		1975		1974		1973		1972		1971		1970		Total	
	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F
Pilot																										
Pilot in Command) Data presented are																										
Co-Pilot) combined totals for these																										
Dual Student) four major subcategories																										
Check Pilot)																										
Failed to see and avoid other aircraft	28	0	24	0	24	0	35	1	38	1	31	0	36	1	43	0	30	1	31	1	36	1	39	0	395	6
Failed to see and avoid objects or obstructions	59	0	56	0	69	0	78	0	78	1	128	2	114	1	105	0	109	0	107	1	91	0	87	1	1081	6
Misjudged distance and/or speed and/or altitude and/or clearance	259	2	261	4	273	2	304	3	295	9	340	8	343	13	361	12	361	18	294	13	376	7	345	8	3812	99
Selected wrong runway relative to existing wind	56	17	53	19	53	18	55	17	57	10	73	11	0	0	67	14	79	18	45	7	42	3	73	7	653	141
Personnel																										
Weather Personnel																										
Incorrect weather forecast	0	0	0	0	0	1	0	0	0	0	1	4	1	3	0	2	1	1	0	1	0	4	1	4	4	20
Inadequate weather forecast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate weather observation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Incomplete weather report	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequately maintained facilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Excessive workload	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate/incorrect weather briefing	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	3
Traffic Control Personnel																										
Failure to advise of unsafe weather condition	0	3	0	3	0	2	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	2	11
Failure to advise of unsafe airport condition	0	1	0	2	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	2	1	0	3	7
Airport Supervisory Personnel (Airport Mgmt)																										
Improper maintenance - airport facilities	1	1	0	2	0	0	1	0	1	1	1	1	2	2	2	0	4	2	2	0	3	1	5	0	22	10
Fail to notify of unsafe cond &/or to mark obstr	5	2	5	1	2	2	1	3	3	3	4	3	2	4	4	1	3	5	6	0	7	3	0	3	50	38
Improper/inadequate snow removal	1	0	0	0	1	4	1	3	7	5	2	2	0	4	2	5	2	0	0	0	3	0	0	4	27	27
Dispatching (Air Carrier Only)																										
Cleared flt with inadequate facilities at dest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airports/Airways/Facilities																										
Airport Facilities																										
Instrument landing system	0	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3
TVOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach lighting	0	1	0	1	0	0	0	0	0	2	0	0	0	1	0	1	1	0	0	1	0	0	1	0	2	7
Runway lighting	0	4	0	10	0	12	1	14	3	16	0	10	0	7	1	7	3	9	0	3	0	5	0	7	8	104
Ramp facilities	0	0	0	0	0	1	0	0	0	0	0	1	0	2	0	0	0	2	1	1	0	1	0	1	1	9
Taxiway lighting and marking	0	1	1	1	0	0	0	1	0	2	0	3	0	1	0	3	0	2	0	0	0	0	0	0	1	14
Obstruction lighting	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	2	0	0	1	5
Airport Conditions																										
Wet runway	3	59	1	42	3	61	1	42	6	50	7	38	5	49	6	52	14	55	4	38	6	45	13	51	69	582
Ice/slush on runway	0	17	1	15	1	32	4	37	2	17	5	15	4	22	4	19	8	155	12	18	9	28	5	26	55	401
Snow on runway	3	26	1	18	5	48	6	53	6	49	6	46	1	40	3	34	14	21	7	32	18	39	27	35	97	441
Snow windrows	0	19	0	18	0	34	7	54	2	34	4	49	1	38	3	53	16	13	6	15	26	19	54	3	119	349
Unmarked obstructions	6	7	2	4	0	7	4	9	1	3	2	9	4	6	1	5	2	10	3	6	5	3	6	3	36	72
Soft shoulders (runway)	0	20	0	24	1	19	2	15	0	15	2	21	2	32	1	25	20	22	6	23	6	5	12	17	52	238

High vegetation	1	38	1	21	4	15	2	15	1	15	6	24	5	23	1	39	5	33	5	19	9	17	10	17	50	276
Hidden hazard	1	4	2	1	5	7	3	2	4	5	10	6	11	8	7	11	8	9	10	7	16	7	14	5	91	72
Poorly maintained runway surface	2	37	1	24	1	22	2	12	7	19	4	19	6	16	5	19	7	11	3	14	3	8	6	10	47	211
Soft runway	1	26	1	32	1	29	1	20	5	22	6	21	6	21	3	24	2	22	17	23	5	17	13	23	61	280
Wet ramp/taxiway	0	1	0	2	0	1	0	0	0	0	0	1	0	0	0	0	1	2	0	1	0	2	0	0	1	10
Ice/slush on ramp/taxiway	0	1	0	2	0	1	0	1	0	5	0	2	1	0	0	2	0	1	0	1	1	2	2	4	4	22
Snow on ramp/taxiway	0	1	0	4	1	3	0	1	0	4	1	4	2	2	0	1	0	3	1	2	2	1	2	1	9	27
Soft shoulders (ramp/taxiway)	0	0	0	1	0	0	0	0	1	2	0	4	0	4	0	1	1	2	1	2	2	0	1	1	6	17
Poorly maintained ramp/taxiway surface	0	0	0	2	1	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	1	0	1	1	5	5
Soft taxiway	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	2	3
Weather																										
Low ceiling	1	74	0	63	0	55	0	59	0	47	1	50	0	58	1	64	2	66	6	67	7	64	10	53	28	720
Rain	0	50	0	49	0	44	0	48	0	45	0	37	0	44	0	45	0	59	6	57	3	54	5	47	14	579
Fog	0	106	0	92	0	86	0	85	1	78	2	73	1	85	1	90	2	92	4	86	10	85	17	71	38	1029
Snow	0	34	0	28	0	26	0	30	0	18	1	24	0	29	0	26	1	24	3	22	6	30	8	22	19	313
Hail	0	1	0	0	0	0	0	0	1	1	0	1	0	1	0	1	0	1	0	0	1	1	1	1	3	8
Icing conditions	0	19	1	32	1	23	1	23	0	15	3	20	3	24	1	24	2	18	7	25	10	12	12	13	41	248
Conditions conducive to carb/induct system icing	0	25	0	18	0	28	0	26	0	29	0	28	1	39	1	35	4	28	21	17	36	5	26	3	89	281
Unfavorable wind conditions	6	173	6	141	9	126	12	135	15	139	34	127	32	130	33	142	48	132	61	109	94	91	100	119	450	1564
Wind shear	3	8	0	6	0	6	0	4	3	3	4	2	3	1	0	0	0	0	0	0	0	0	0	0	13	30
Sudden wind shift (takeoff or landing)	2	15	1	10	3	7	3	6	7	10	5	6	6	11	5	10	6	8	5	7	6	6	6	4	55	100
Local whirlwind	1	2	2	1	2	1	2	1	4	1	2	2	6	1	3	2	4	1	4	1	4	1	4	1	38	15
Squall line	0	1	0	0	0	1	0	1	0	0	0	1	0	1	0	1	0	2	1	0	1	0	1	1	3	9
High temperature	0	7	0	8	0	2	0	14	0	13	0	10	0	7	0	8	0	10	1	14	1	14	1	24	3	131
Obstructions to vision (smoke, haze, sand, dust)	0	13	1	10	0	6	0	9	0	8	7	7	0	8	1	8	2	9	2	11	1	4	0	0	14	93
High density altitude	0	78	0	52	0	40	1	38	0	48	1	42	0	44	0	49	2	44	4	51	5	46	8	54	21	586
Thunderstorm activity	0	35	1	23	0	26	2	24	2	23	4	20	3	24	1	29	3	25	7	22	4	24	6	19	33	294
Terrain																										
Hidden Obstruction	1	8	0	6	2	8	2	5	7	5	5	2	13	30	7	7	9	7	5	3	14	4	14	2	79	87
High Obstructions	0	94	3	150	11	167	34	151	44	166	46	264	53	299	63	323	78	302	87	203	115	148	113	110	647	2377
Miscellaneous																										
Animal(s) on runway/taxiway/ramp	11	2	9	3	10	2	4	1	12	0	6	1	7	1	16	2	7	1	3	1	8	1	8	3	101	18
Sabotage	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	4	0
* SUBTOTAL, "AIP-MITIGATED" CITATIONS *	452	1034	435	948	483	977	570	963	615	942	756	1025	677	1139	754	1198	861	1248	789	934	995	812	1075	779	8462	11999
% of Total Citations	8%	31%	8%	31%	8%	31%	8%	32%	8%	32%	9%	31%	8%	32%	9%	29%	10%	34%	10%	31%	12%	34%	12%	35%	22%	32%
ALL OTHER CITATIONS b/	5232	2321	5354	2148	5712	2143	6596	2007	6833	2025	7225	2236	7373	2474	8005	2892	7780	2410	7078	2076	7586	1578	8019	1468	29905	25778
GRAND TOTAL CITATIONS b/	5684	3355	5789	3096	6195	3120	7166	2970	7448	2967	7981	3261	8050	3613	8759	4090	8641	3658	7867	3010	8581	2390	9094	2247	38367	37777

a/ FAA-APO-220 analysis, based in part on References 15 and 16.
b/ Excludes "Miscellaneous Acts, Conditions."

APPENDIX B-2

"AIP-Mitigated" Cause/Factor Citation Frequency, Air Carrier Operations, CY1970 - CY1981 a/

Cause/Factor Citation	1981		1980		1979		1978		1977		1976		1975		1974		1973		1972		1971		1970		Total	
	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F
Pilot																										
Pilot in Command) Data presented are																										
Co-Pilot) combined totals for these																										
Dual Student) four major subcategories																										
Check Pilot)																										
Failed to see and avoid other aircraft	4	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	10	0
Failed to see and avoid objects or obstructions	5	0	5	0	0	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	14	0
Misjudged distance and/or speed and/or altitude and/or clearance	16	0	16	0	1	0	1	0	1	0	3	0	2	0	1	0	1	1	1	1	1	0	2	0	46	2
Selected wrong runway relative to existing wind	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Personnel																										
Weather Personnel																										
Incorrect weather forecast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2
Inadequate weather forecast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate weather observation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Incomplete weather report	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequately maintained facilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Excessive workload	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate/incorrect weather briefing	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Traffic Control Personnel																										
Failure to advise of unsafe weather condition	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Failure to advise of unsafe airport condition	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Airport Supervisory Personnel (Airport Mgmt)																										
Improper maintenance - airport facilities	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1
Fail to notify of unsafe cond &/or to mark obstr	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Improper/inadequate snow removal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dispatching (Air Carrier Only)																										
Cleared flt with inadequate facilities at dest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Airports/Airways/Facilities																										
Airport Facilities																										
Instrument landing system	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
TVOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach lighting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Runway lighting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ramp facilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taxiway lighting and marking	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Obstruction lighting	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Airport Conditions																										
Wet runway	0	2	0	9	0	1	0	1	0	1	0	0	1	0	0	0	2	0	1	0	0	1	1	0	5	15
Ice/slush on runway	0	2	0	3	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	1	1	9
Snow on runway	0	2	0	3	0	0	0	0	0	1	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	10
Snow windrows	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	7
Unmarked obstructions	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Soft shoulders (runway)	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	3

High vegetation	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hidden hazard	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3
Poorly maintained runway surface	0	4	1	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9
Soft runway	0	2	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Wet ramp/taxiway	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Ice/slush on ramp/taxiway	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Snow on ramp/taxiway	0	1	0	1	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	4
Soft shoulders (ramp/taxiway)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poorly maintained ramp/taxiway surface	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soft taxiway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Weather																										
Low ceiling	1	27	0	23	0	1	0	1	0	0	0	1	0	2	0	1	0	3	1	3	0	4	0	2	2	68
Rain	0	6	0	10	0	1	0	0	0	1	0	1	0	1	0	1	0	2	1	2	0	1	1	1	2	27
Fog	0	25	0	21	0	1	0	1	0	0	0	1	0	1	0	2	0	1	0	3	0	5	0	2	0	63
Snow	0	13	0	5	0	1	0	0	0	0	0	2	0	2	0	0	0	1	0	0	0	1	0	0	0	25
Hail	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
Icing conditions	0	5	1	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	12
Conditions conducive to carb/induct system icing	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Unfavorable wind conditions	1	11	0	14	0	1	0	0	0	1	1	0	0	1	0	0	1	1	0	0	1	0	1	1	5	30
Wind shear	1	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	2
Sudden wind shift (takeoff or landing)	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Local whirlwind	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Squall line	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
High temperature	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Obstructions to vision (smoke, haze, sand, dust)	0	4	0	3	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	11
High density altitude	0	7	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Thunderstorm activity	0	3	0	6	0	1	0	1	1	1	1	0	1	1	0	1	1	2	3	2	0	1	0	1	7	20
Terrain																										
Hidden Obstruction	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
High Obstructions	0	7	0	8	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	18
Miscellaneous																										
Animal(s) on runway/taxiway/ramp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sabotage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
* SUBTOTAL, AIR CARRIER "AIP-MITIGATED" CITATIONS *	30	140	30	142	1	11	1	5	6	11	7	8	7	12	3	11	8	15	7	12	4	16	9	9	113	392
% of Total Air Carrier Citations	9%	51%	8%	54%	2%	50%	2%	24%	11%	58%	15%	50%	9%	32%	4%	35%	12%	47%	8%	75%	5%	57%	10%	35%	8%	50%
ALL OTHER AIR CARRIER CITATIONS b/	316	136	324	119	44	11	45	16	47	8	40	8	73	25	78	20	59	17	78	4	78	12	80	17	1262	393
TOTAL AIR CARRIER CITATIONS b/	346	276	354	261	45	22	46	21	53	19	47	16	80	37	81	31	67	32	85	16	82	28	89	26	1375	785

a/ FAA-APO-220 analysis, based in part on Reference 15.
b/ Excludes "Miscellaneous Acts, Conditions."

APPENDIX B-3

"AIP-Mitigated" Cause/Factor Citation Frequency, General Aviation, CY1970 - CY1981 a/

Cause/Factor Citation	1981		1980		1979		1978		1977		1976		1975		1974		1973		1972		1971		1970		Total	
	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F	C	F
Pilot																										
Pilot in Command) Data presented are																										
Co-Pilot) combined totals for these																										
Dual Student) four major subcategories																										
Check Pilot)																										
Failed to see and avoid other aircraft	24	0	21	0	24	0	35	1	37	1	31	0	36	1	43	0	30	1	31	1	34	1	39	0	385	6
Failed to see and avoid objects or obstructions	54	0	51	0	69	0	78	0	77	1	127	2	114	1	104	0	108	0	107	1	91	0	87	1	1067	6
Misjudged distance and/or speed and/or altitude and/or clearance	243	2	245	4	272	2	303	3	294	9	337	8	341	13	360	12	360	17	293	12	375	7	343	8	3766	97
Selected wrong runway relative to existing wind	56	17	51	19	53	18	55	17	57	10	72	11	0	0	67	14	79	18	45	7	42	3	73	7	650	141
Personnel																										
Weather Personnel																										
Incorrect weather forecast	0	0	0	0	0	1	0	0	0	0	1	4	1	3	0	2	1	1	0	1	0	3	1	3	4	18
Inadequate weather forecast	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequate weather observation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Incomplete weather report	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inadequately maintained facilities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Excessive workload	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
In. lequate/incorrect weather briefing	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3
Traffi.: Control Personnel																										
Failure to advise of unsafe weather condition	0	3	0	2	0	2	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	9
Failure to advise of unsafe airport condition	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	2	1	0	0	3	4
Airport Supervisory Personnel (Airport Mgmt)																										
Improper maintenance - airport facilities	1	1	0	2	0	0	1	0	1	0	1	1	2	2	2	0	3	2	2	0	3	1	5	0	21	9
Fail to notify of unsafe cond &/or to mark obstr	4	1	4	0	2	2	1	3	3	3	4	3	2	4	4	1	3	5	6	8	7	3	8	3	48	36
Improper/inadequate snow removal	1	0	0	0	1	4	1	3	7	5	2	2	0	4	2	5	2	0	0	0	3	0	8	4	27	27
Dispatching (Air Carrier Only)																										
Cleared flt with inadequate facilities at dest	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Airports/Airways/Facilities																										
Airport Facilities																										
Instrument landing system	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
TVOR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach lighting	0	1	0	1	0	0	0	0	0	2	0	0	0	1	0	1	1	0	0	1	0	0	0	0	1	7
Runway lighting	0	4	0	10	0	12	1	14	3	16	0	10	0	7	1	7	3	9	0	3	0	5	0	7	8	104
Ramp facilities	0	0	0	0	0	1	0	0	0	0	0	1	0	2	0	0	0	2	1	1	0	1	0	1	1	9
Taxiway lighting and marking	0	0	1	1	0	0	0	1	0	2	0	3	0	1	0	3	0	2	0	0	0	0	0	0	1	13
Obstruction lighting	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	2	0	0	1	4
Airport Conditions																										
Wet runway	3	57	1	33	3	60	1	41	6	49	7	38	4	49	6	52	12	55	3	38	6	44	12	51	64	567
Ice/slush on runway	0	15	1	12	1	32	4	37	2	17	5	14	3	21	4	19	8	154	12	18	9	28	5	25	54	392
Snow on runway	3	24	1	15	5	48	6	53	6	48	6	46	1	39	3	31	14	21	7	32	18	39	27	35	97	431
Snow windrows	0	16	0	15	0	34	7	54	2	34	4	49	1	38	3	52	16	13	6	15	26	19	53	3	118	342
Unmarked obstructions	5	7	2	3	0	7	4	9	1	3	2	9	4	6	1	5	2	10	3	6	5	3	6	3	35	71
Soft shoulders (runway)	0	18	0	24	1	18	2	15	0	15	2	21	2	32	1	25	19	22	6	23	6	5	12	17	51	235

High vegetation	1	37	1	21	4	15	2	15	1	15	6	24	5	23	1	39	5	33	5	19	9	17	10	17	50	275
Hidden hazard	1	3	2	1	5	6	3	2	4	5	10	6	11	8	7	11	8	8	10	7	16	7	14	5	91	69
Poorly maintained runway surface	2	33	0	20	1	22	2	12	7	18	4	19	6	16	5	19	7	11	3	14	3	8	6	10	46	202
Soft runway	1	24	1	27	1	29	1	20	5	22	6	21	6	21	3	24	2	22	17	23	5	17	13	23	61	273
Wet ramp/taxiway	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	2	0	1	0	2	0	0	1	9
Ice/slush on ramp/taxiway	0	0	0	2	0	1	0	1	0	3	0	2	1	0	0	2	0	1	0	1	1	2	2	4	4	19
Snow on ramp/taxiway	0	0	0	3	1	3	0	1	0	2	1	4	1	2	0	1	0	3	1	2	2	1	2	1	8	23
Soft shoulders (ramp/taxiway)	0	0	0	1	0	0	0	0	1	2	0	4	0	4	0	1	1	2	1	2	2	0	1	1	6	17
Poorly maintained ramp/taxiway surface	0	0	0	2	1	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	1	0	1	1	5	5
Soft taxiway	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	2	3
Weather																										
Low ceiling	0	47	0	40	0	54	0	58	0	47	1	49	0	56	1	63	2	63	5	64	7	60	10	51	26	652
Rain	0	44	0	39	0	43	0	48	0	44	0	36	0	43	0	44	0	57	5	55	3	53	4	46	12	552
Fog	0	81	0	71	0	85	0	84	1	78	2	72	1	84	1	88	2	91	4	83	10	80	17	69	38	966
Snow	0	21	0	23	0	25	0	30	0	18	1	22	0	27	0	26	1	23	3	22	6	29	8	22	19	288
Hail	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	0	1	0	1	1	2	7
Icing conditions	0	14	0	26	1	22	1	23	0	15	3	20	3	24	1	24	2	18	7	25	10	12	11	13	39	236
Conditions conducive to carb/induct system icing	0	23	0	18	0	28	0	26	0	29	0	28	1	39	1	35	4	28	21	17	36	5	26	3	89	279
Unfavorable wind conditions	5	162	6	127	9	125	12	135	15	138	33	127	32	129	33	142	47	131	61	109	93	91	99	118	445	1534
Wind shear	2	7	0	5	0	6	0	4	2	3	4	2	2	1	0	0	0	0	0	0	0	0	0	0	10	28
Sudden wind shift (takeoff or landing)	2	14	1	8	3	7	3	6	7	10	5	6	6	11	5	10	6	8	5	7	6	6	6	4	55	97
Local whirlwind	1	1	2	1	2	1	2	1	4	1	2	2	6	1	3	2	4	1	4	1	4	1	4	1	38	14
Squall line	0	1	0	0	0	1	0	1	0	0	0	1	0	1	0	1	0	1	1	0	1	0	1	1	3	8
High temperature	0	6	0	8	0	2	0	14	0	13	0	10	0	7	0	8	0	10	1	14	1	14	1	24	3	130
Obstructions to vision (smoke, haze, sand, dust)	0	9	1	7	0	6	0	8	0	8	7	7	0	7	1	8	2	9	2	10	1	3	0	0	14	82
High density altitude	0	71	0	44	0	39	1	38	0	48	1	42	0	44	0	49	2	44	4	51	5	46	8	54	21	570
Thunderstorm activity	0	32	1	17	0	25	2	23	1	22	3	20	2	23	1	28	2	23	4	20	4	23	6	18	26	274
Terrain																										
Hidden Obstruction	1	6	0	5	2	8	2	5	7	5	5	2	13	30	7	7	9	7	5	3	14	4	14	2	79	84
High Obstructions	0	87	3	142	11	167	34	151	44	166	46	264	53	298	63	322	78	301	87	203	115	148	113	110	647	2359
Miscellaneous																										
Animal(s) on runway/taxiway/ramp	11	2	9	3	10	2	4	1	12	0	6	1	7	1	16	2	7	1	3	1	8	1	8	3	101	18
Sabotage	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0
* SUBTOTAL, G.A. "AIP-MITIGATED" CITATIONS *	422	894	405	806	482	966	569	958	609	931	749	1017	670	1127	751	1187	853	1233	782	922	991	796	1066	770	8349	11607
% of Total G.A. Citations	8%	29%	7%	28%	8%	31%	8%	32%	8%	32%	9%	31%	8%	32%	9%	29%	10%	34%	10%	31%	12%	34%	12%	35%	9%	31%
ALL OTHER G.A. CITATIONS b/	4916	2185	5030	2029	5668	2132	6551	1991	6786	2017	7185	2228	7300	2449	7927	2872	7721	2393	7000	2072	7508	1566	7939	1451	81531	25385
GRAND TOTAL G.A. CITATIONS b/	5338	3079	5435	2835	6150	3098	7120	2949	7395	2948	7934	3245	7970	3576	8678	4059	8574	3626	7782	2994	8499	2362	9005	2221	89880	36992

a/ FAA-APO-220 analysis, based in part on Reference 16.
b/ Excludes "Miscellaneous Acts, Conditions."

APPENDIX C

Discounting of Streams of Benefits and Costs to Present Value

The discount formula used in this report for discounting streams of benefits and costs over time to a common present value numeraire is:

$$1/\ ((1 + i)^n) \times \text{Future Year Benefits or Costs}$$

where 'i' is the standard discount rate of ten percent as prescribed by OMB Circular A-94 (Reference 14) and 'n' is the year. As pointed out in the text of the report, a typical AIP investment is assumed to have a twenty-year economic life for purposes of quantifying benefits and recurring costs. It is also assumed that realizable benefits begin accruing one year following the initial investment, i.e., a 1 year lag between initial investment and operational readiness.

The following table outlines solutions (rounded to nearest thousandth) for the above discount formula for n = -3 to 20 at a discount rate (i) of ten percent.

ANNUAL DISCOUNT FACTORS @ 10%

Year	Number of Years (n) from Today (1985)	Discount Factor
1982	-3	1.331
1983	-2	1.210
1984	-1	1.100
1985	0	1.000
1986	1	.909
1987	2	.826
1988	3	.751
1989	4	.683
1990	5	.621
1991	6	.564
1992	7	.513
1993	8	.467
1994	9	.424
1995	10	.386
1996	11	.350
1997	12	.319
1998	13	.290
1999	14	.263
2000	15	.239
2001	16	.218
2002	17	.198
2003	18	.180
2004	19	.164
2005	20	.149

APPENDIX D

G.N.P. Implicit Price Deflators

The index used in this report for redenominating or converting dollars from one year to another is the Nominal G.N.P. (Total) Implicit Price Deflator. This series, with a base of 1972 = 100, is reproduced below for all historic and forecast period years addressed in this report:*

Year	G.N.P. I.P.D.	Year	G.N.P. I.P.D.	Year	G.N.P. I.P.D.
1947	49.55	1967	79.06	1987	234.28
1948	52.98	1968	82.54	1988	238.78
1949	52.49	1969	86.79	1989	243.18
1950	53.56	1970	91.45	1990	247.88
1951	57.09	1971	96.01	1991	253.08
1952	57.92	1972	100.00	1992	258.58
1953	58.82	1973	105.75	1993	264.08
1954	59.55	1974	115.08	1994	269.58
1955	60.84	1975	125.79	1995	275.28
1956	62.79	1976	132.34	1996	281.08
1957	64.93	1977	140.05	1997	286.98
1958	66.04	1978	150.42	1998	292.88
1959	67.60	1979	163.42	1999	298.68
1960	68.70	1980	178.42	2000	304.48
1961	69.33	1981	195.60	2001	310.28
1962	70.61	1982	207.38	2002	315.98
1963	71.67	1983	215.34	2003	321.68
1964	72.77	1984	223.38	2004	327.38
1965	74.36	1985	226.98	2005	333.18
1966	76.76	1986	230.28		

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* 1947 - 1983 = Actual, per Reference 23.

1984 = Preliminary, per Reference 23.

1985 - 2005 = Forecast, based on FAA-APO-220 analysis of Reference 24.

APPENDIX E

Historic and Forecast Annual Airport Activity (Millions of Aircraft Operations) a/

	At Airports WITH FAA Traffic Control Service b/							Annual Aircraft Opns at Airports WITHOUT FAA Air Traffic Control Service c/			
			General Aviation		Military						
Fiscal Year	Air Carrier	Air Taxi/ Commuter	Itinerant	Local	Itinerant	Local	Sub-Total	Air Carrier	General Aviation	Sub-Total	Total
1970	10.8	e/	22.6	19.4	1.5	1.9	56.2	0.0	50.4	50.4	106.6
1971	10.1	e/	22.0	18.6	1.5	2.0	54.2	0.0	48.0	48.0	102.2
1972	9.7	2.0	20.4	18.1	1.5	2.0	53.7	0.0	47.7	47.7	101.4
1973	9.8	2.1	20.6	18.1	1.5	1.8	53.9	0.0	47.5	47.5	101.4
1974	9.5	2.4	22.9	19.3	1.3	1.5	56.9	0.0	49.7	49.7	106.6
1975	9.4	2.7	24.2	20.0	1.3	1.4	59.0	0.0	51.0	51.0	110.0
1976 d/	9.3	2.9	26.2	21.4	1.3	1.4	62.5	0.6	54.3	54.9	117.4
1977 d/	9.8	3.3	28.1	22.9	1.3	1.4	66.8	0.5	55.4	55.9	122.7
1978	10.1	3.8	28.5	22.3	1.2	1.3	67.2	0.5	62.5	63.0	130.2
1979	10.4	4.4	29.4	22.3	1.2	1.3	69.0	0.6	65.9	66.5	135.5
1980	10.1	4.6	28.3	20.6	1.2	1.3	66.1	0.6	72.3	72.9	139.0
1981	9.5	4.9	26.4	18.2	1.2	1.3	61.5	0.6	74.5	75.1	136.6
1982	9.0	5.1	20.7	13.5	1.1	1.2	50.6	0.6	76.9	77.5	128.1
1983	9.7	5.9	21.3	14.0	1.2	1.3	53.4	0.4	75.4	75.8	129.2
1984	10.9	6.6	22.3	14.7	1.2	1.2	56.9	0.2	78.1	78.3	135.2
1985	11.2	7.2	23.3	15.4	1.2	1.2	59.5	0.2	81.9	82.1	141.6
1986	11.4	7.6	25.0	16.5	1.2	1.2	62.9	0.2	83.5	83.7	146.6
1987	11.6	7.9	26.8	17.8	1.2	1.2	66.5	0.2	84.9	85.1	151.6
1988	11.9	8.3	28.8	19.2	1.2	1.2	70.6	0.2	86.0	86.2	156.8
1989	12.2	8.6	31.0	20.7	1.2	1.2	74.9	0.1	86.5	86.6	161.5
1990	12.4	9.0	33.6	22.5	1.2	1.2	79.9	0.1	86.1	86.2	166.1
1991	12.6	9.4	34.5	23.2	1.2	1.2	82.1	0.1	88.4	88.5	170.6
1992	12.9	9.7	35.3	24.0	1.2	1.2	84.3	0.0	91.1	91.1	175.4
1993	13.2	10.1	36.1	24.7	1.2	1.2	86.5	0.0	93.7	93.7	180.2
1994	13.4	10.5	36.8	25.4	1.2	1.2	88.5	0.0	96.6	96.6	185.1
1995	13.6	10.8	37.2	26.1	1.2	1.2	90.1	0.1	99.9	100.0	190.1
1996	13.9	11.2	37.7	26.7	1.2	1.2	91.9	0.0	103.2	103.2	195.1
1997	14.2	11.5	38.4	27.4	1.2	1.2	93.9	0.0	106.2	106.2	200.1
1998	14.5	11.8	39.1	28.1	1.2	1.2	95.9	0.0	109.1	109.1	205.0
1999	14.8	12.1	39.7	28.8	1.2	1.2	97.8	0.0	112.1	112.1	209.9
2000	15.1	12.4	40.3	29.5	1.2	1.2	99.7	0.0	115.1	115.1	214.8
2001	15.4	12.7	40.9	30.2	1.2	1.2	101.6	0.0	118.0	118.0	219.6
2002	15.7	13.0	41.5	30.9	1.2	1.2	103.5	0.0	120.9	120.9	224.4
2003	16.0	13.3	42.1	31.6	1.2	1.2	105.4	0.0	123.9	123.9	229.3
2004	16.3	13.6	42.7	32.3	1.2	1.2	107.3	0.0	126.9	126.9	234.2
2005	16.6	13.9	43.3	33.0	1.2	1.2	109.2	0.0	129.9	129.9	239.1

a/ An "aircraft operation" is an aircraft arrival or departure.

b/ Sources: For FY1970 - FY1996 activity data, annual editions of Reference 25.
For FY1997-FY2007 activity data, FAA-APO-220 extrapolation of Reference 25 data.

c/ Source: Reference 26 (encompassing operations at approximately 4,000 airports), after netting out Reference 25 data.

d/ Activity during the transition quarter (7/1/76 - 9/30/76) is excluded.

e/ Air taxi included with general aviation prior to 1972.

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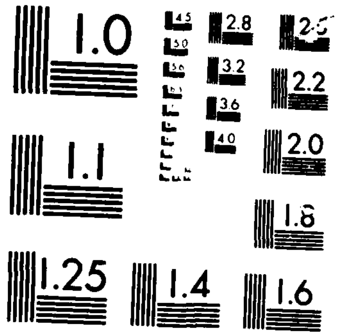

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